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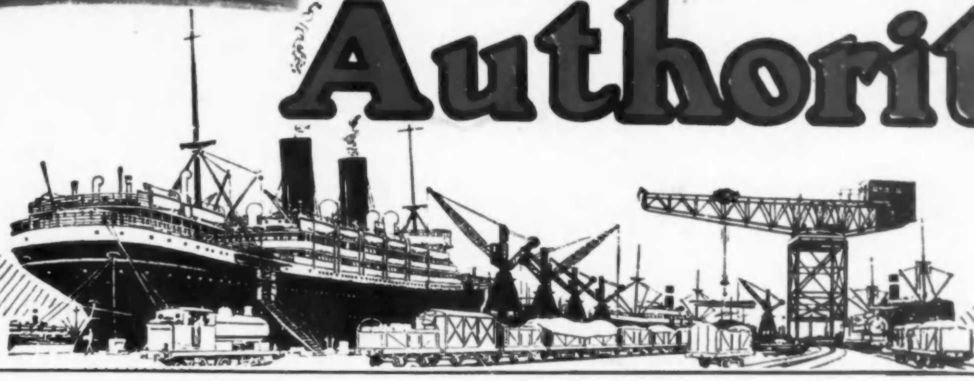

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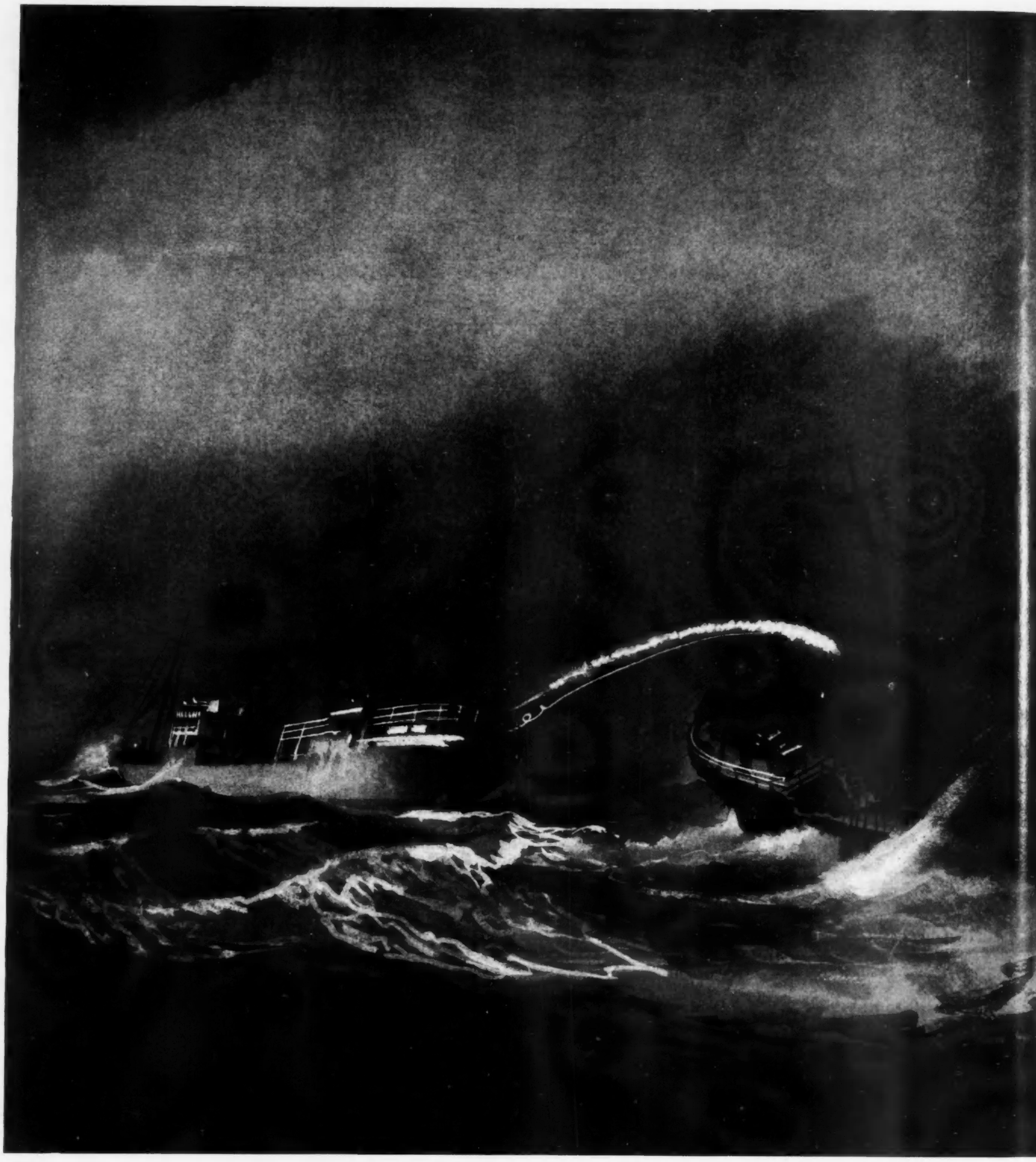

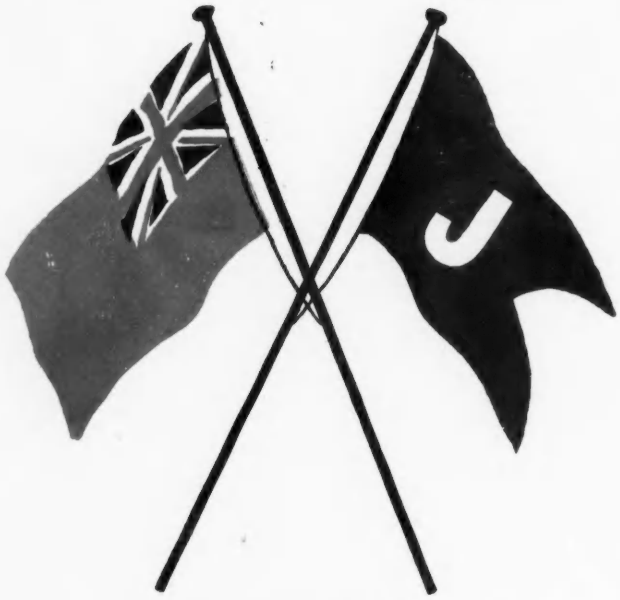
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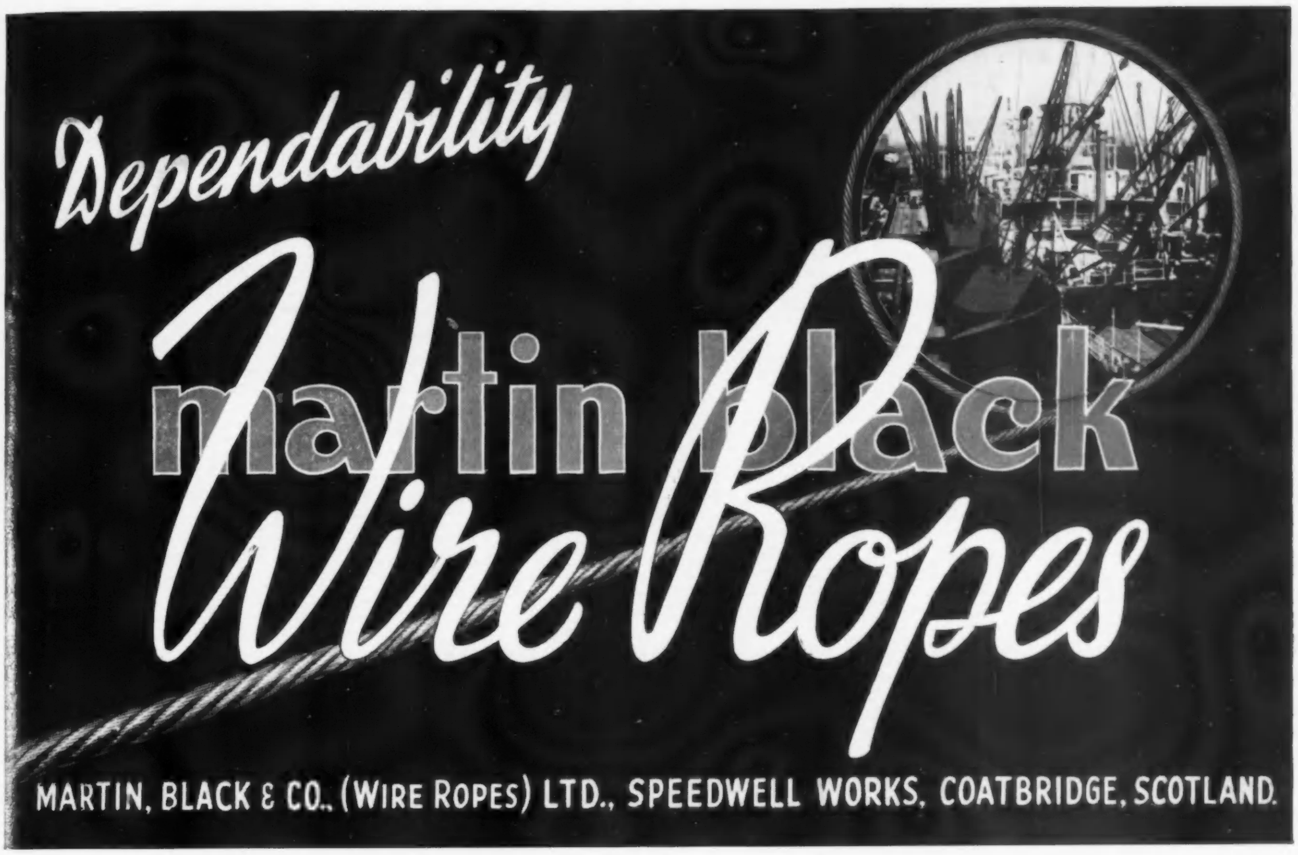
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The Dock and Harbour Authority

No. 257. Vol. XXII. Edited by BRYSSON CUNNINGHAM, D.Sc. B.E., F.R.S.E., M.Inst.C.E. MARCH, 1942

CONTENTS

Editorial Comments

A New Zealand Harbour Problem.

Following recent consideration of the characteristics of some of the more notable ports of the world, it will probably be an agreeable variation if our readers' attention is directed to one of the lesser known and smaller ports. As a matter of fact, features of maritime interest are by no means confined to large ports; there is often much to be learned in port operation from the activities of those of minor significance in world commerce. The problems they present are no less engrossing and may even be of greater educational value than some which are more impressively spectacular.

The relatively inconspicuous harbour of Greymouth, New Zealand, furnishes a case in point. Compared with other ports in many parts of the world it exhibits no outstanding volume of trade: the leading exports are coal and timber, and imports are covered by the term general merchandise. Locally, it has considerable importance, for there are large deposits of coal in the Grey River district and many mines are being worked, while as regards timber, which is almost exclusively soft wood, practically the whole of the export trade of the Dominion passes through Greymouth on its way to Australia.

The feature of particular interest is the fact that it is a " bar harbour," which connotes a serious impediment to navigation confronting the majority of harbours of this type, but whereas certain ports of ample resources, such as Liverpool on the Mersey and Bordeaux on the Gironde Estuary, have been able to remedy the evil by means of costly and powerful dredging appliances, the more modest resources of the New Zealand port have necessitated recourse to less expensive expedients. Readers will no doubt recall the report presented in July, 1938, to the Greymouth Harbour Board by their engineer, Mr. David C. Milne, which was contained in a communication to this Journal, published in the following October. The application of a system of groyning along the foreshore adjacent to the Grey River was therein shown be effective in restraining the drift of the shore material which led to the formation and alimentation of the bar. Since the date of his report, Mr. Milne has amplified his treatment of the subject in a Paper presented to the Institution of Civil Engineers, which we have the pleasure of reproducing in the current number.

In the 1937-8 Vernon-Harcourt Lectures on Estuary Channels and Embankments, we took the view that, in the main with certain exceptions, the origin of river bars is to be attributed to the process of littoral drift, and it is interesting to have this confirmatory evidence from the experience at Greymouth.

We are indebted to Mr. Milne for some additional particulars about the work of the port. He says that coal is sent to the quays in specially constructed steel hopper wagons of 8 and 10-ton capacity. The hoppers are lifted by hydraulic cranes and discharged into the ships' holds at an average rate of 180 tons per hour per crane. The port is well equipped with railway sidings and marshalling yards. Timber is brought in by rail from the interior where the clearance of the forest areas is succeeded by dairy farming. There is still a considerable extent of virgin bush and saw-milling is likely to be a leading occupation for many years to come.

The climate of the district at sea level is mild and genial, while the background scenery of lakes and forests, with glaciers on the snow-clad range of the Southern Alps, which rise to heights of over 12,000-ft., is magnificent.

Port Congestion in South Africa.

As will be seen from a report on another page of a conference recently held at Pretoria, it is evident that port congestion troubles have manifested themselves in South African ports to an extent which has caused considerable perturbation in official circles. The conference was attended by all the leading harbour officials of the Union and was addressed by the Prime Minister, General Smuts, who pointed out the urgency of the problem of port clearance and emphasised his view that a great increase in shipping traffic round the Cape was inevitable under the conditions arising out of the present war situation. He impressed upon the conference the necessity of producing results. " You are business men," he said; " not parliamentarians or debaters," and therefore, " you are the men to get on with the job."

The advice is sound and salutary, and applicable to port workers everywhere. The present is not a time for talking, but for action; and though preliminary consultation is desirable, and even necessary, yet opinions and advice must be justified by results, which can only be achieved by prompt and resolute action.

The ensuing discussion at the conference will be of interest to readers in this country as indicating the particular weaknesses which have developed in South African port operation. Some of them are undoubtedly common to this country.

The Port of Hong Kong.

In the present issue, Mr. John Duncan, former Port Engineer, continues his animadversions on the proposals put forward by the late Sir David Owen for the future Control and Development of the Port of Hong Kong. Mr. Duncan discusses these proposals with an intimate knowledge of the locality and of the relative circumstances up to the time of his retirement. We are glad to give publicity to his views, which must carry due weight, for it would be presumptuous on our part to offer observations on controversial details of purely local significance.

Our readers may think that the present time, when Hong Kong is completely in the hands of the enemy, is scarcely a suitable opportunity to discuss plans for the future development of the port. On the other hand, it will be felt by all those who, like ourselves, have complete confidence in the ultimate outcome of the present struggle, that these plans may advantageously be thoroughly investigated in readiness for prompt action whenever the moment becomes favourable.

The American Association of Port Authorities.

Various impediments incidental to the prevalence of a state of world-wide hostilities, including delays in postal transmission, have operated to prevent, until lately, the receipt of any account of the Annual Convention of the American Association of Port Authorities which was held in Miami, Florida, at the beginning of November, last. At length, however, press accounts have

Editorial Comments - *continued*

come to hand and we are now able to make a somewhat belated reference to the proceedings of the Convention.

The chief topic of interest and discussion seems to have been the threatened action in Congress by the Federal Government to substantiate and implement a claim to the ownership of all tidally submerged and reclaimed lands in port districts. We have already alluded to this matter in an Editorial Comment in our issue of February, 1941, and readers will perhaps recall that the controversy has arisen out of a local incident at Los Angeles, California, involving a government claim to certain oil-bearing areas in the harbour of that port desired by the United States Naval authorities, following which the Attorney General of the United States on December 4th, 1940, instituted an action in the Federal Court of Southern California for the appropriation by the Government of "certain reclaimed submerged lands on Terminal Island, Los Angeles Harbour." In that suit, according to a manifesto issued by the Association at the Convention, "the United States asserts that it does not concede that either California or the City of Los Angeles has any right, title, estate or interest adverse to the United States in the reclaimed submerged lands in question."

At the time of our earlier Comment, it was pointed out that the issue, though apparently local, was of grave and far-reaching importance to all harbour authorities in the United States. In many cases, extensive reclamation work has already been undertaken and the reclaimed sites have been utilised for port development installations, which are now in commission. Should the United States Government be successful in its present action, it is contended by the Association that a precedent would thereby be established enabling submerged and reclaimed areas at any port to be seized without compensation. "We have been frankly informed," said Mr. A. W. Nordstrom, assistant city attorney of Los Angeles, "that the United States wants complete title to the land without paying for it, because it considers that it already owns it."

The issue, manifestly, is far wider than the mere acquisition of a small oil-bearing site: it involves the legal ownership of numerous wharves, quays, sheds and their appurtenances which have been constructed all along the coastline on reclaimed land, and the American Association of Port Authorities are offering strenuous opposition to any such claim. The Association's committee on law and legislation, of which Mr. Julius Cohen, general counsel of the Port of New York Authority, is chairman, have instructed counsel to act on their behalf at the hearings. So far as our information goes at the moment, the matter is still *sub judice*, being no doubt over-shadowed by more important state defence measures necessitated by the entry of the United States into the war.

Port Development was the subject of a report to the Convention by Commander G. F. Nicholson of the United States Navy in his capacity as chairman of the Association's Committee on Port Development and Construction. The report stated that while public port authorities had designed and constructed few new terminal facilities in recent years, the War and Navy Departments in the present emergency had built and were building "many new marine terminal facilities, such as quay wharves, piers, transit sheds, waterfront warehouses and supporting railway, street and utility improvements" in connection with the Defence Programme and that the procedure would "without question" continue as long as the present emergency lasted.

A number of other committee reports were presented; they cannot be detailed here, though reference to some of them may be desirable in subsequent issues. Mention, however, should be made of an address on "Port Planning and Terminal Design in relation to Economical Cargo Handling," by Professor H. E. Stocker, of New York University. His address dealt particularly with problems which he had studied at the Port of Honolulu and was amplified by data from other localities. Explaining how congestion at Honolulu Harbour had been reduced, he said that some relief had been obtained by the greater utilisation of open areas near some of the piers, by moving cement in bulk instead of in bags, and by stacking commodities higher than previously, with the use of modern cargo handling equipment. Congestion at the port had been aggravated by the fact that large motor trucks, engaged in receiving and delivering cargo, required a good deal of space in which to manœuvre. The use of such trucks had created new problems for port terminal operators, which had not yet been fully met by improvements in terminal design.

The Convention lasted for several days, the concluding session on November 8th being devoted to the election of officers for the ensuing year. The new president (as announced in our February issue) is Mr. John M. Wilson, of Toronto, Canada, district engineer of the Canadian Government for the Great Lakes. The next Convention of the Association is to be held at the Port of Hamilton on Lake Ontario, during September next, the precise date remaining to be decided later.

Ill-fated Singapore.

February 15th, 1942, will long be remembered as a tragic date in the annals of the British Empire in the East. Singapore, highly, and it was thought impregnably, fortified, has, for the time being, fallen into enemy hands with consequences of the gravest character to the British and American naval and military operations in the Pacific.

It is not the province of this Journal to deal with naval bases or harbours, used wholly or mainly for military purposes, except perhaps, in so far as they contain features and installations which are of common constructional interest to commercial docks and harbours, our legitimate sphere. An exception, which is justifiable on this ground, may be made as regards the capital of the Straits Settlements, which, designed primarily as a powerful naval base, became concurrently a great commercial and transhipment port, with trade of the order of several millions sterling annually. The commercial shipping visiting the port reached in 1936 a total tonnage of over thirty millions.

The island, on which the city and port stand, measures about 27 miles long and 14 miles broad, with an area of 225 sq. miles, and it has a population in normal times of three-quarters of a million. It was acquired for the East India Company, in 1819, by Sir Stamford Raffles from the Sultan of Johore for a small pecuniary payment, being then merely a desert island. Its strategic value, however, was considerable, and the transaction was undoubtedly at the time a piece of wise and far-seeing statesmanship.

During the ensuing 120 years to the present date, sums variously stated at between 20 and 30 millions have been expended on development works and fortifications, though, till quite recently, apparently, no British fleet had been stationed in the commodious harbour. The Naval Dockyard was equipped with a graving dock of outstanding size, 1,000-ft. long with 130-ft. entrance width, capable of receiving the largest battleships and with a floating dock having a lifting capacity of 50,000 tons. These splendid repairing facilities placed Singapore in the forefront of British naval stations and it was looked upon as a supreme guardian of British commerce in Eastern waters—a fortress as significant and impregnable as Gibraltar.

The commerce of the port has been varied and valuable. Exports included gambier, copra, tin, rubber, palm oil, hides, sago, tapioca, pepper, tortoise-shell, mother-of-pearl, gutta percha, spices, camphor, coffee and shellac. There is accommodation in the commercial harbour for vessels drawing up to 35-ft. and the wharves and jetties are accessible at all times, the total quayage, including that of a well-sheltered wet dock, being 12,774 lin. ft. Facilities for coaling were available, by coolie labour up to 4,000 tons per day and by mechanical coal handling plant at 200 tons per hour. The total coal storage accommodation coal handling plant aggregated 180,000 tons.

Protective Regulations at American Ports.

Both in Canada and the United States, special port defence regulations have recently been issued by the respective governments.

In Canada, in extension of a previous Order in Council, port authorities of "Defended Ports" are explicitly given jurisdiction over "the movement, navigation, pilotage, anchorage, mooring, berthing, lighting and related matters" and a Navy Department notice decrees that no vessel may enter a "defended port" without first proceeding to the designated examination anchorage, neither may it leave the anchorage or enter port therefrom without the permission of the examining officer. Masters of vessels must obey all regulations or any special signals which may be given. Ships may not leave a defended port without the permission of the requisite authority.

Ports classed as "Defended Ports" are Halifax (Nova Scotia), Esquimalt-Victoria (British Columbia), and any other port declared to be "defended" by order of the Defence Minister or the Minister for the Navy.

In the United States, President Roosevelt has issued an executive order designating a number of port "Defence Areas." Among them on the Atlantic seaboard are New York, Boston, Delaware Bay and Charleston Harbours. The order declares that any vessel entering a defensive sea area, does so at its own risk and must not enter or navigate the waters of a defensive area except during daylight, when good visibility conditions prevail, and then only after specific permission has been obtained. Even when permission has been given, it is incumbent on vessels to obey further instructions received from the United States Navy or other United States Authority.

Challenge to Dockers.

Mr. J. Gibson Jarvie, North West Regional Port Director, has issued a challenge to dock workers in the North-West area, which includes Liverpool, Manchester, Preston, Barrow and all ports lying between Holyhead and Silloth, to prove their capabilities to the utmost during the week from March 8th to March 14th. They are asked to make new records for celerity and despatch and to avoid all slacking and absenteeism. The idea is commendable, but its application should not be limited to a single week. Indeed, the pity is that it should be necessary to issue an appeal to all in the present crisis. The country is fighting for its very existence and loyal citizens should need no incitement to do their utmost in the struggle.

Port of Greymouth, New Zealand

The Problem of a Bar Harbour*

By D. C. MILNE, B.Sc., M.Inst.C.E.

Early Improvement Work

THE port of Greymouth, situated on the West Coast of the South Island, New Zealand was known as a seaport for some 20 years prior to the constitution of the Harbour Board in 1884. It was not, however, until after the Board took over the control of the port that a comprehensive scheme of harbour development was undertaken.

The scheme adopted was that recommended by Sir John Coode, which provided for the construction of two breakwaters to give an entrance width of 400-ft. on the low water line, the formation of training banks along the North side of the river, the construction of 1240-ft. of wharf and a certain amount of dredging and reclamation.

A loan of £100,000 was raised by the Board in 1885 and the scheme was carried to completion. The breakwaters and training walls were of the rubble mound type and were constructed of limestone obtained from the Board's quarries. The work was carried out by contract, and upon its completion a depth of 19-ft. at high water was obtained at the entrance and in the navigation channel.

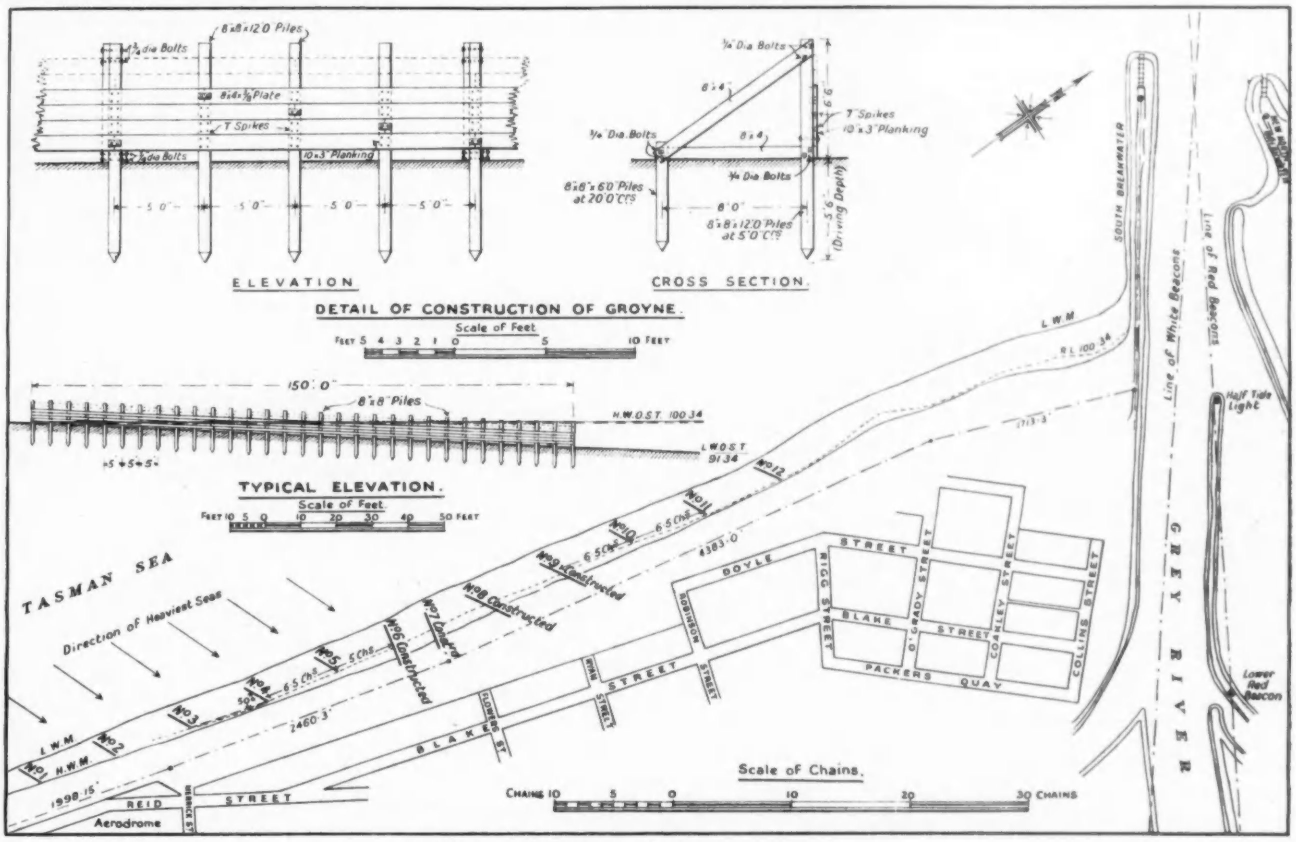
This met adequately the requirements of the shipping at that time, and no further works of a major character were carried out until 1903 when the construction of a new North Breakwater was commenced. Persistent agitation on the part of the shipping community for a wider entrance resulted in the Board agreeing to the construction of another breakwater on the North side parallel to the existing one, but about 200-ft. further to the North, with a view to providing an entrance width of 600-ft. on the low water line. Before the completion of this work in 1906, it became evident that the scour from the river would be insufficient to maintain an entrance of 600-ft. and this was reduced to its present form of 500-ft. on the low water line.

During the next 25 years various small extensions were made to the breakwaters and training walls and a considerable amount of maintenance and restoration work was carried out on the entrance works, which are swept by heavy seas and in consequence, require constant attention.

Concurrently with the improvement of the entrance works and navigation channel, the Board pursued a progressive policy with regard to the provision of shipping accommodation and wharfage facilities. From time to time extensions were made to the existing wharfage to meet the requirements of the expanding trade of the port and mechanical equipment was installed on the wharves to facilitate the handling of cargo and expedite the despatch of vessels.

Later Developments

The size of vessels frequenting the port has steadily increased and in 1925 it became evident that the Board would have to consider the provision of additional facilities if they were to meet the needs of a larger class of vessel and retain the trade of the port. A commission of engineers was, therefore, appointed and asked to investigate the position and formulate a scheme for improving the port.



Greymouth Harbour. Groynes at Blaketown.

The scheme suggested by them and approved by the Board dealt chiefly with the improvements of the harbour entrance and navigation channel and was designed to give an increased depth on the bar which is the governing factor in limiting the draft of shipping using the port. The method recommended was the progressive extension seawards of both breakwaters and the development of a tidal compartment by dredging the lagoons to the South of the Grey River.

The berthage required for the larger vessels which might be expected to use the port when the entrance improvements are completed will be provided by utilizing the tidal harbour formed by dredging the lagoons. Although the preparatory work in connection with this scheme was commenced in 1926, a considerable amount of restoration work was necessary on both breakwaters and it was not until 1931, when the author took control of the work, that the extension of the South Breakwater was commenced.

The first section of this work amounting to 300 lin. ft. was completed in 1936. The construction of the North Breakwater extension was commenced in 1934, and is still in progress. The length of the latter extension is 425 lin. ft. Before the commencement of the present extension the head of the South Breakwater extended seawards 125-ft. beyond the head of the North Breakwater. The object of this overlap was to provide protection from the prevailing South-Westerly seas for ships navigating the harbour entrance. With the larger vessels now frequenting the port, this design of the entrance works became ineffective and under certain conditions even dangerous. The author, therefore, recommended that the heads of the breakwaters should be made co-terminus and this condition will be obtained on the completion

*Paper published in abstract in the Journal of the Institution of Civil Engineers and reproduced by permission.

Port of Greymouth, New Zealand—continued

of the present extension to the North Breakwater. The breakwaters will then be able to exercise their maximum influence in directing the river current on to the bar and an improvement in bar depths may be anticipated.

Breakwater Construction

Both breakwaters are of the rubble mound type and are similar in cross section with a top width of 25-ft., side slopes above high water mark of 1½ to 1 and below high water mark on the seaward face the slopes are approximately 3 to 1. The average bottom width is 197-ft. The level of the tops of both breakwaters is 20-ft. above H.W.O.S.T. and the South Breakwater is provided with a parapet wall on the Southern side.

The stone was deposited by means of side-tip wagons from a staging constructed with ironbark piles and rimu superstructure. The piers were placed at 25-ft. centres and consisted of two piles 16-in. by 9-in. corbels and half-caps. The stringers were formed by 14-in. by 14-in. trussed beams with 1⅜-in. dia. tension rods and were supported on 14-in. by 14-in. corbels which were bolted to the half-caps. The structure was stiffened laterally by heavy wrought iron knee braces 9-ft. in length by 3-in. in diameter which were attached to the piles and half-caps by 1¼-in. dia. bolts. The staging carried two railway lines of 3-ft. 6-in. guage which were placed so that the piles came on the centre lines of each track which were 25-ft. apart.

Owing to the presence of *Teredo* which is very active in the locality, the staging was constructed in short lengths of 75-ft. in order to reduce the time the piles were exposed to *Teredo* attack before being protected by stone. In spite of this precaution, several piles had to be replaced after only nine months immersion in the sea. In each case the pile broke at a point approximately 1-ft. below low water mark and in this region of greatest *Teredo* activity the pile had been so reduced in cross sectional area that it broke under the action of heavy seas.

Wave Force

The harbour entrance is very exposed and is subjected to severe storms from the South-West. Experience has shown that only very large stones are able to withstand the influence of wave-action which becomes more pronounced in its effects as the breakwaters advance seawards. During South-Westerly gales stones of over 20 tons in weight have been moved along the breakwaters a distance of 70-ft. and on one occasion a stone of 12 tons was lifted vertically upwards a distance of 6-ft. by wave action while stones under 10 tons in weight have been swept from the new mound and lost in the sea. Under these circumstances, therefore, it was decided that the bulk of the stone used in the construction of the breakwaters should be over 10 tons in weight and this object was kept in view in the conduct of quarry operations.

Quarry Work

The stones for the extensions was obtained from Cobden Quarry which is owned by the Board and is located about 1½ miles from the North Breakwater. A railway line of 3-ft. 6-in. guage connects the quarry with the North Breakwater and transport for the latter extension was provided by the Board which owns two steam locomotives and 20 side tip wagons capable of taking loads up to 30 tons. In addition there are 10 side tip wagons which are used in the transport of spoil and the smaller class of stone. The transport of stone to the South Breakwater extension was provided by the New Zealand Railway Department which supplied the locomotives and the personnel required.

The quarry is well equipped with railway sidings and mechanical equipment. Four steam cranes are used of lifting capacities—25 tons, 20 tons, 15 tons, and 7 tons. A Bucyrus Steam Shovel of 1-cub. yd. capacity is used in handling spoil which is excavated and loaded by this machine at a cost of 4½d. per ton. Permanent air mains are laid on the quarry floor consisting of 2-in. dia. piping which can be tapped at various points to supply compressed air to the pneumatic hammers operating at the working face. Two air compressors are employed, one having a capacity of 92-cu. ft. and the other 220-cu. ft. Both compressors are driven by means of short centre belt drives from electric motors.

In order to obtain stone for the extensions it was decided to fire a large tunnel shot on a scale which had not hitherto been attempted in the Dominion. The execution of this project presented unusual features and will be described in detail.

Cobden Quarry consists of a good quality arenaceous limestone which has been laid down in well-marked benches of thickness varying from 6-ft. up to 15-ft. The dip of the strata is 32° and numerous clearly defined dip joints are visible throughout the quarry. The general appearance of the strata conveys the impression of gigantic upheavals in past ages and is characteristic of New Zealand geological formations. The dip joints in some cases are confined to certain strata, while in others the joints extend through several benches. The presence of these joints renders the design of a large shot somewhat uncertain and in previous blasts it was ascertained that where the height of the rock overhead was great, the explosion merely blew out the face and left the rock in the upper strata arched. Various explosives, have, at different times, been used for large tunnel shots in the quarry and ordinary blasting powder has been found to give the most satisfactory results. Careful observations taken during previous blasts have indicated that if the shot is so designed that the height of rock overhead is approximately one and a half times the line of least resistance more successful results were obtained.

Three tunnels were driven in the same stratum at right angles to the dip and at different elevations above the quarry floor, the main drives in each case being carried back to one of the principal dip joints. The toe on the western face was cut back until the lower side of the stratum carrying the tunnels were visible above the quarry floor. As an additional precaution against the toe resisting the action of the explosive, the western face was undercut by drilling a number of vertical holes and shattering the rock by a charge of gelignite to a depth of 3-ft. below the floor level.

In calculating the charges, the height of the rock above each chamber was accurately determined by a tacheometrical survey and the line of least resistance was taken as two thirds of the overhead height the chambers being so located as to develop this condition. The charge in each chamber was obtained from the formula:—

$$\text{Charge in lbs.} \quad \frac{(\text{Line of least resistance})^3}{36.}$$

and the result was checked by calculating the horizontal radii of rupture for each charge by means of the following formula —

$$\text{Effective H.R.R.} \quad K \sqrt[3]{C \frac{10 \quad e}{S}}$$

where e 1.0 (For Blasting Powder)
S 2.0 } Constants for moderately
K 1.4 } hard rock
C Charge in lbs.

The final result gave the charges as follows:—

Chamber	L.L.R.	H.R.R.	Charge
A	45.0-ft.	33.0-ft.	2550 lbs.
B	47.5-ft.	34.4-ft.	2950 lbs.
C	45.0-ft.	33.0-ft.	2550 lbs.
D	32.5-ft.	23.5-ft.	950 lbs.
E	32.5-ft.	23.5-ft.	950 lbs.
F	45.0-ft.	33.0-ft.	2550 lbs.
G	35.0-ft.	25.0-ft.	1150 lbs.
H	32.5-ft.	23.5-ft.	950 lbs.
		Total	14600 lbs. of Blasting Powder

The driving of the tunnels occupied 55 days and was carried out on three shifts with two men on each shift. The size of the tunnels was approximtely 3-ft. 6-in. by 3-ft. 6-in. and in each main drive was laid a tramway carrying a small end-tip wagon which greatly facilitated the removal of the debris after each round of shots was fired.

The total length of the tunnel driven including the chambers was 393-ft. The cost of driving the tunnel was as follows:—

	£	s.	d.
Gelignite, detonators and fuse	74	9	9
Air Compressors, running costs	52	6	6
Lighting of Tunnels	6	1	1
Miscellaneous	24	0	0
Labour (Wages 17/6 per 8-hr. shift)	284	14	2
Total	£441	11	6

	£	s.	d.
Cost per lin. ft.	1	2	6
Cost per cu. yd.	2	9	5
Total weight of stone removed	457.17 tons		
Total quantity of Gelignite used	575 lbs.		
Weight of stone per lb. Gelignite	0.621 ton		

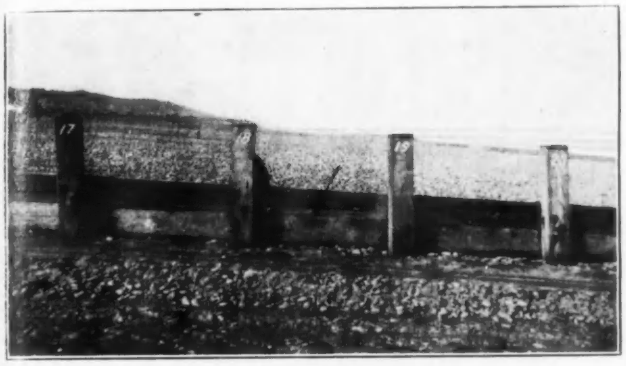
All three tunnels leaked badly during wet weather. In No. 3 Tunnel, the chambers which had been driven down the dip, collected water very quickly and after a few hours heavy rainfall all three chambers were completely flooded. Under these circumstances it became imperative to provide adequate protection for the powder against damage from the seepage of water. Eight boxes, each designed to contain the whole of the charge to be used in a chamber, were made of tongued and grooved timber ½-in. in thickness, so constructed that they could readily be conveyed to their proper places and there put together. Each box after being placed in a chamber was lined with malthoid the joints of which were lapped and held by solution. The front of the box was left open to enable the charge to be placed, after which the box was closed and the malthoid which had been left projecting was lapped across and solutioned. For the purpose of calculating the dimensions of the boxes one cubic foot of powder was assumed to weight 54-lbs. and the result was entirely satisfactory, the powder comfortably filling each box.

The powder was delivered in 50-lb. cases which were opened and the bags of powder packed into the large boxes in the chamber. Flax handles were then attached in the empty powder boxes which were used to convey the tamping into the tunnels. The invert level of No. 1 Tunnel was 68-ft. above the quarry floor while the invert levels of No. 2 and No. 3 Tunnels were

Port of Greymouth, New Zealand—continued

45-ft. and 24-ft. respectively. In order to facilitate the handling of the powder and tamping a tramway was constructed up the face of the quarry to deliver the materials to the various tunnels. The tamping, which consisted of quarry spoil containing a certain percentage of clay, was deposited as required on the loading platform at the lower end of the tramway where it was placed in the powder cases and conveyed by a small wagon, operated by an electrically driven friction winch, to the mouth of the tunnel. The only electric motor available for the winch was 3 h.p. and this restricted the load taken at each lift to 12 boxes. From the mouth of the tunnel the boxes were skidded along planks to the working face by a chain of men. The work was carried out on three shifts and the number of men on each shift was varied according to the distance of the working face from the tunnel mouth. In practice the system worked smoothly and the tamping proceeded at the average rate of 31 lin ft. of tunnel or 14 cubic yds. of tamping per shift.

In placing the tamping, the space between the box and the sides of each chamber was first carefully packed with clay and in order to protect the powder from the wet concrete a 6-in. wall of pug was built across the front of the box. Each charge was then concreted in—the mix consisting of nine parts of ballast to one part of quick hardening cement. The concrete plug extended to about 1-ft. into each chamber and 1-ft. along the main drive on either side of it. Stone walls faced with pug formed the shutters for the concrete in the main drive and prevented the leakage



Groyne No. 6. April 1st, 1937.

of the cement grout through the tamping. In using blasting powder, the relatively slow action of the explosive renders it of the very highest importance that the tamping should be fully effective and the efficiency of a properly formed concrete plug in this connection unquestionably repays the labour and expense involved. The average time taken to place each concrete plug was 2¼ hours and the total quantity of concrete used in the eight plugs amounted to 18 cubic yds. which required approximately 2 tons of cement.

The shot was fired electrically by means of a 50 watt transformer placed on the 230 volt power mains. The ignition system was laid in duplicate and the electric leads were protected throughout by timber casings. By using two entirely independant systems of ignition the possibility of a missfire through damage to the electric leads was reduced to a minimum. In order to distinguish the circuits and avoid confusion in wiring the primers, one circuit was laid in red cable while the other was in black. In each chamber on the red circuit two No. 7 detonators were connected in series and placed in a packet of gelignite, each detonator being embedded in a plug. Two additional packets of gelignite, were added as a booster one being placed on each side of the primer. The black circuit was connected to a length of 25-ft. of Cordeau-Bickford fuse which was placed in each chamber and coiled through the powder, a No. 7 detonator being attached to each end of the cordeau fuse and connected in series. The six tunnel circuits with the detonators in series were connected in parallel across the power mains and the duplicate systems were fired simultaneously. As the tamping of the various tunnels proceeded, continuity tests were made at each change of shift and the galvanometer deflections were carefully recorded. Owing to the limited capacity of the transformer it became necessary to determine with some degree of accuracy, the total resistance of the electrical system in order to ensure that the current was of sufficient strength to fire all the charges. No information was available regarding the fusing point current and resistance of the No. 7 detonators and these quantities had to be determined by actual test on a number of detonators. The result showed that the current of fusing point varied between 0.50 and 0.75 amps. and the resistance between 1.75 and 2.0 ohms. The transformer was capable of giving a current of one ampere for each circuit and this was considered sufficient

The shot was fired on the 25th February, 1932 and the result was entirely satisfactory. A survey made after the blast gave the quantity of stone brought down as 105,000 tons of 7.2 tons of stone per lb. of powder. Approximately 75 per cent of the total quantity consisted of stone over 2 tons in weight and was therefore admirably adapted for the purpose for which it was intended

The total cost of shot was as follows:—

	£	s.	d.
Driving Tunnels	441	10	9
Loading, Tamping and Concreting ...	209	8	1
Explosives, Detonators and Fuse	944	1	9
Powder Boxes	32	16	8
Lighting	32	3	4
Power—Air Compressor, Winch, etc. ...	16	19	0
Installing Transformer, etc.	13	13	9
Miscellaneous	21	14	0
	£1,712	7	4

Total quantity of Stone brought down 105,000 tons.
Cost per ton of Stone 3.91d.

The daily rates of pay for men employed on the work were as follows:—

Tunnellers	17/6
Labourers	16/6
Crane Drivers and Loco. Drivers ...	17/6
Carpenters	18/6

The following classification is used for stone used in the construction of the breakwaters; 1st class stone over 10 tons, 2nd class stone 5 tons to 10 tons, 3rd class stone 2 tons to 5 tons

The large quantity of stone which was available at the quarry as a result of the blast enabled the construction of the South Breakwater to proceed vigorously. The method of construction

Groyne No. 6. April 12th, 1937.

was to form banks on either side of the staging consisting of first class and third class stone deposited in alternate layers. This system not only had the effect of reducing the voids between the larger stones but, by providing a cushion, materially reduced the breakages in tipping. The core was formed by depositing alternate layers of second and third class stone with a small percentage of first class stone to protect the core from storm damage during construction. The head was formed by specially selected stones of between 20 and 25 tons in weight and since completion has withstood the effect of several storms of exceptional severity without alteration in profile. Although the slope of the seaward face was constructed at approximately 1½ to 1, it has flattened considerably below high water mark, and now approaches the calculated ultimate profile of 3 to 1. The depth of the water at the head is 19-ft. at low water and the average depth of water over the extension is 16-ft. at low water, the tidal range being 9-ft.

The total quantity of stone used in the extension is as follows:—

1st Class	55,000 tons	57 per cent.
2nd Class	28,000 tons	29 per cent.
3rd Class	13,000 tons	14 per cent.
	96,000 tons	100 per cent.

	Amount £	Rate per ton
Stone, 96,000 tons	37,600	7/10
Staging (Construction)	3,250	8.1
Railway Maintenance	1,040	2.6
Tipping Stone and Manufacture of Staging	2,320	5.8
Transport	3,600	9.2
Total	£47,810	9/11.7

Quantity of Stone per lin. ft. 320 tons.
Cost per lin. ft. of breakwater £159.

The extension of 425 lin. ft. to the North Breakwater is still under construction. The method adopted is similar to that used on the South Breakwater. The general profile and cross sectional area approximate closely to those of the South Breakwater although the average depth of water is rather less being only 14-ft. at low water while the head will finish in 18-ft. low water. The convenient location of the work with relation to the quarry and the fact that all transport of stone is carried out by the Board with its own locomotives and staff has resulted in a much more flexible arrangement being adopted in the deposition of stone. It has, therefore, been possible to accumulate stone in large quantities at the quarry and transport it rapidly to the breakwater

Port of Greymouth, New Zealand—*continued*

when sea conditions were favourable. This was not possible in the construction of the South Breakwater where transport arrangements had to be made in advance with the Railway Department and a time-table rigidly adhered to. Up to the end of April, 1939 when the author left New Zealand, the total quantity of stone deposit amount to 85,500 tons in the following proportions:—

1st Class Stone	...	31,500 tons	37 per cent.
2nd Class Stone	...	29,500 tons	34 per cent.
3rd Class Stone	...	25,000 tons	29 per cent.
	Total	85,500 tons	100.00 per cent.

The total expenditure up to April, 1939 amount to £33,487 or 7/10d. per ton of stone deposited. The length of breakwater completed amounted to 300 lin. ft. and the quantity of stone per lin. ft. was 285 tons. The cost per lin. ft. amounted to £111.

Bar Investigation

Concurrently with the construction of the breakwater a very careful investigation, extending over a number of years, was conducted into the question of bar conditions with a view to discovering whether the harbour entrance could be improved by an alteration in the alignment or relative position of the breakwater extensions or whether the effect produced on the bar by the breakwater extensions could be supplemented by other works.

An initial step in the enquiry was to establish definitely the cause of the extremely rapid variations both in location and extent which are characteristic of the Grey Bar and to determine whether these unstable conditions were produced by *detritus* carried down by the river or whether they were due to external agencies which have their origin in off-shore or coastal conditions.

The material carried down by the river in flood consists chiefly of very heavy gravel up to 6-in. in diameter and the current velocity during floods occasionally exceeds 10 knots. The effect of floods on the bar is generally to improve the depth of water while shoaling occurs at the berthages. Under normal conditions the current velocity does not exceed 2 knots and the only material brought down by the river is fine mud and silt which passes out to sea without being deposited on the bar. Samples of material taken from the bar from time to time were found to consist of fine sand, the grains of which had the rounded appearance characteristic of sea sand while the material dredged from the berthages was coarse gravel containing generally not more than 10 per cent of sand the grains of which were coarse and angular in appearance. It was apparent, therefore, that the bar was not formed by *detritus* carried down by the river and that the influence exercised by the latter on the harbour entrance was due to fluctuations in the scouring action produced by variations in current velocity on material carried along the coast by ocean currents or wave action.

The existence of a main ocean current moving in a Northerly direction along the coast appears to be a firmly established local tradition, but a careful investigation carried out in this connection did not support this belief. A large number of surface and deep water floats were used and many observations were taken within a radius of two miles seaward of the harbour entrance. The method employed was to use two floats in each series of observations. One float was controlled by vanes set at a depth of 3-ft. below the surface while the vanes of the other were set at 12-ft. below surface level. Both floats were released simultaneously at mid-stream opposite pier No. 245 at the lower end of the wharf and the current velocities were measured between this point and the light on the head of the South Breakwater. Outside the harbour entrance the paths of the floats were located by means of theodolite bearings, two instruments being used, one on the head of the South Breakwater and the other on the head of the North.

The following is an analysis of the off-shore current observations:—

Direction		Percentage	Velocity
South	... ...	33	44— 86-ft./Min.
West	... ...	45	64—155-ft./Min.
North	... ...	22	106—420-ft./Min.

The high velocity of approximately 4¼ knots which was recorded in the case of one float moving in a Northerly direction occurred during a period of heavy South-Westerly swell when the observed height of the waves at the harbour entrance was 6-ft. In each of the other cases where the floats took a Northerly course the swell was from the South-West and the observed height of waves at the harbour entrance ranged between 4-ft. and 6-ft. The relatively high velocities attained by the floats which moved in a Northerly direction were due to the combined effect of the river current and the heavy South-Westerly swell. The result of these observations was to eliminate ocean currents as agencies in producing shoaling of the Bar.

It was established, however, that accretion at the harbour entrance occurred during periods of South-Westerly seas and during these periods material accumulated rapidly on the foreshore to the South of the harbour. The material on the beach consisted chiefly of fine sand comparable with samples obtained from the bar. The rate of accretion was generally uniform along the foreshore and on one occasion after 14 days continuous South-Westerly seas the level of the beach was raised from two to four ft. between high and low water marks. The quantity of material deposited during this period on the beach between the South Breakwater and a point one mile to the South amounted to approximately 80,000 cub. yds. The period of South-Westerly swell was followed by 48 hours of Northerly seas which produced rapid erosion of the foreshore and lowered the beach level, an average height of 3-ft. The erosion was most pronounced near low water mark where the level of the beach dropped a maximum height of over 5-ft. It was estimated that of the 80,000 cub. yds. accumulated during the period of 14 days approximately 50,000 cub. yds. were removed during the 48 hours of Northerly seas.

Observations taken over a long period established that South-Westerly seas were always accompanied by accretion on the foreshore while Northerly seas which rarely exceed 48 hours duration produced exceedingly rapid erosion. The rate of travel of material along the beach was measured and it was established that during moderate Northerly seas the sand and shingle moved Southwards at an average rate of ½-mile per 24 hours, and that during heavy seas the rate of travel was increased approximately one mile in 24 hours. The rate of travel of sand and shingle along the beach in a Northerly direction varied between ¼-mile and ½-mile in 24 hours according to sea conditions.

The investigation revealed that fluctuations in bar depth varied with the movement of the littoral drift along the coast from South to North under the influence of the prevailing South-Westerly swell. Under normal conditions the river velocity is sufficient to deal effectively with the littoral set and a state of equilibrium results with the bar depth more or less stable. If this state of equilibrium is disturbed by an increase in the littoral drift or by a decrease in the river current, temporary and local accretion will result. In the rare event of these factors being coincident serious shoaling inevitably occurs.

These latter conditions were operative in the early part of 1936 when the depth of water on the bar was reduced to 16-ft. at H.W.O.S.T. During February of that year moderate but continuous South-Westerly swell prevailed, accretion occured along the beach to the South of the harbour and the bar depth became progressively less. Between the 6th and the 17th of the following month heavy South-Westerly seas were experienced and a survey made on the 17th revealed that the bar had not only increased in a vertical direction but had extended laterally to a point some 300-ft. seaward of its normal position. Approxiately 38,000 cub. yds. of material were deposited on the bar and between the 1st February and the 17th March the total accretion on the bar amounted to 75,000 cub. yds. reducing the bar depth from 23-ft. to 16-ft. at H.W.O.S.T. and disorganising shipping movements at the Port. Current observations taken throughout this latter period disclosed that the maximum current velocity occurring at half ebb did not exceed 1¼ knots while at quarter and three-quarter ebb the velocity fell to less than ¾ knot.

Between the 23rd and 26th March, Northerly and Westerly seas prevailed and 17,500 cub. yds. of material were removed from the bar solely as a result of the scouring action produced by six ebb tides—2,900 cub. yds. being removed during each ebb tidal period of six hours. Between the 26th and the 31st March when light Westerly and South-Westerly seas were experienced and the river current was increased to a maximum velocity of 3 knots, 100,000 cub. yds. of material were removed from the bar during 11 ebb tides—an average of approximately 9,000 cub. yds. during each ebb tidal period of six hours.

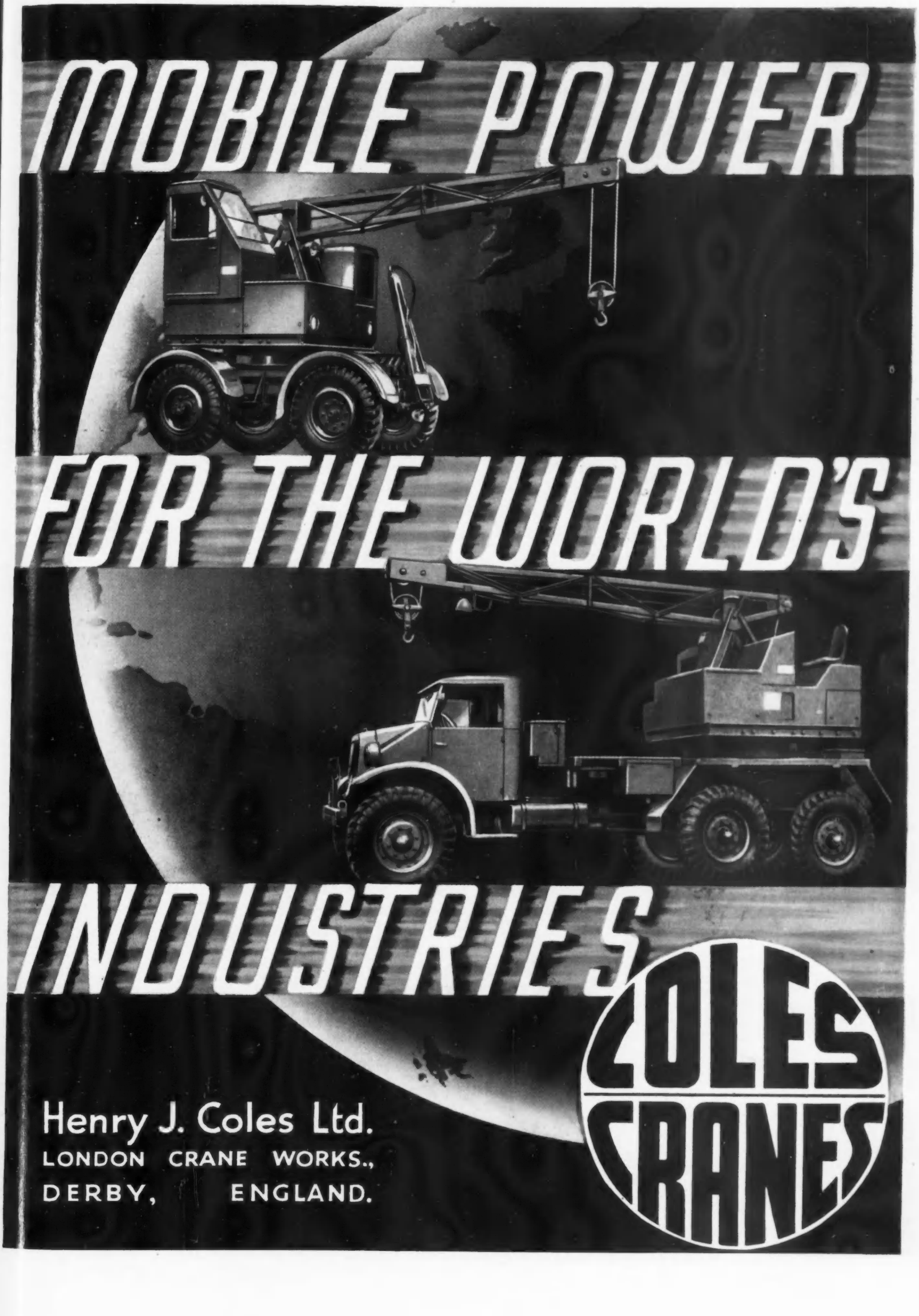
A considerable amount of erosion occurred on the beach between the 23rd and the 31st March and at the end of April after two short periods of Northerly seas the beach was restored to the condition which obtained at the beginning of February.

Groyne Installation

The investigation not only establishes definitely the cause of bar shoaling but it also suggested a means of effecting an improvement in the entrance conditions. If by a system of groynes constructed along the foreshore to the South of the harbour, a proportion of the littoral drift could be intercepted an improvement in bar depth might reasonably be expected.

Observations taken on the beach and surveys made of the bar convinced the author that any scheme which was designed to effect an improvement on bar depth would have to deal with enormous quantities of material. The littoral drift along the coast amounts approximately 1½ million cub. yd. per annum and any system of groynes designed to permanently build up the beach would quickly become buried and inoperative so far as exercising any influence on the bar was concerned. But it had been definitely established that rapid erosion took place during Northerly seas and this led the author to suppose that it might be possible to arrest the travel of a considerable proportion of the littoral drift by a system of groynes and that the material so accumulated would be eroded during Northerly seas and the groynes therefore restored to a condition which would enable them to operate effectively during the next period of Southerly weather.

There would thus be no serious disturbance of the natural conditions which obtain along this coast and the effect of the groynes would be to increase the accretion during South-Westerly seas and by arresting the travel of the littoral drift before it reached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Port of Greymouth, New Zealand—continued

the harbour entrance an improvement in bar depths might be expected. The success of the scheme, however, depended on the anticipation that the groynes would not affect the erosion which takes place during Northerly seas. This was a matter which could only be determined by experiment on a large scale and with this object in view the Board authorized the construction of four groynes. This work was commenced in May and completed in October, 1937. Two of the groynes Nos. 6 and 7 were built at right angles to H.W.M. while groynes 8 and 9 were constructed in a South-Westerly direction at approximately 50° to H.W.M.

The Spring tidal range at Greymouth is 9-ft. and the groynes extended from approximately H.W.M. to L.W.M. The length of the groynes which were built at right angles to the shore line was 150-ft. while those which were built at an angle were 275-ft. The distance between the groynes was 400-ft. and the most Southerly of the four groynes was located about 7,000-yds. South of the harbour entrance.

The groynes consisted of 8-in. by 8-in. timber piles 9-ft. in length driven to a depth of approximately 6-ft. and spaced at 5-ft. centres carrying 10-in. by 4-in. planking three planks high bolted in to the piles. Stay piles were driven at 20-ft. centres on groynes Nos. 8 and 9 to resist wave action during Northerly seas.

In August groynes Nos. 6 and 7 had been completed and only the seaward ends of Nos. 8 and 9 remained to be constructed. Moderate South-Westerly seas prevailed almost without interruption throughout this month and the opportunity was presented of observing the action of the groynes in arresting the littoral drift over a relatively prolonged period.

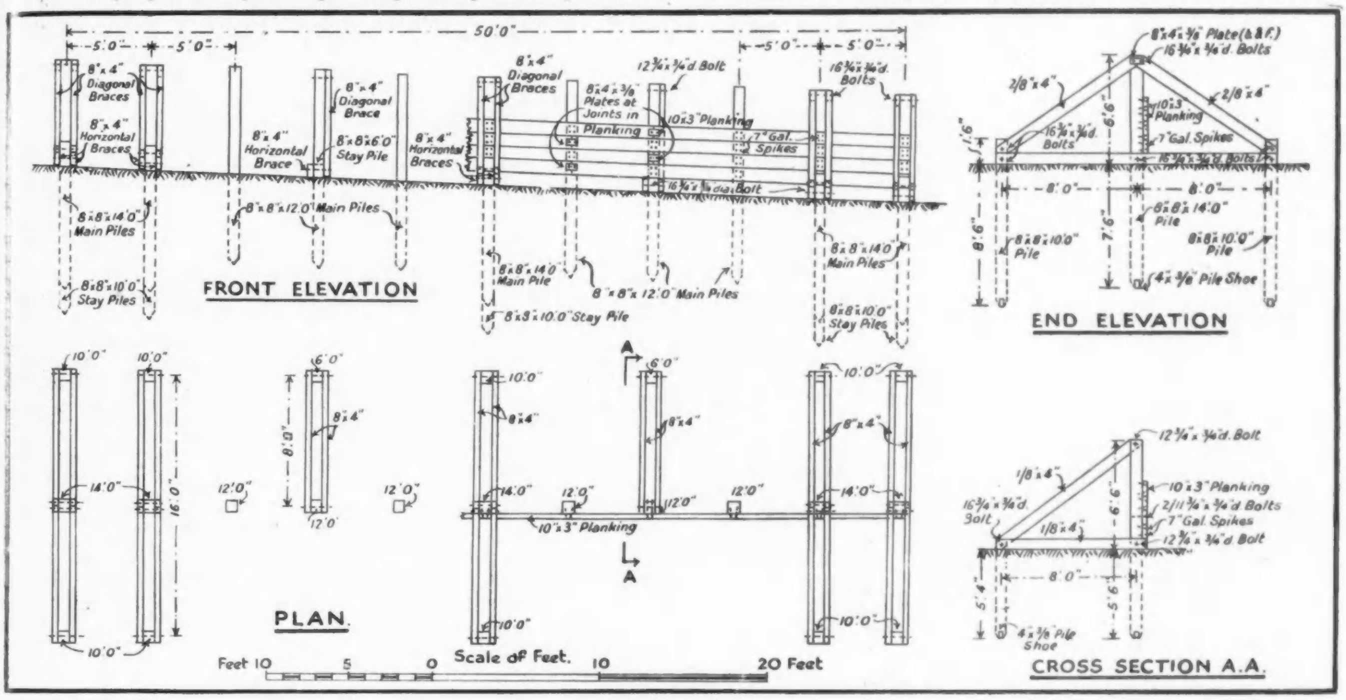
It was observed that sand and shingle rapidly accumulated between the groynes and the beach level in places was raised to a height of over 6-ft. The accretion which was at first confined to the area between the groynes then extended rapidly to the South of No. 6 groyne and more slowly to the North of No. 9 groyne. At the end of the month the area which had been affected by the groynes extended from a point 10 chains to the North of No. 9 groyne to a point 30 chains to the South of No. 6 groyne. The total length of beach affected by the groynes was 60 chains and the total quantity of material accumulated amounted to 85,000 cub. yds. The greatest accretion occurred in the vicinity of the groynes and became progressively less to the North and South.

In the following month Northerly seas were experienced for a period of 48 hours between the 6th and the 8th resulting in general erosion of the beach. Between groynes Nos. 8 and 9 where the accretion had been greatest approximately 20,000 cub. yds. of sand and shingle were removed and the beach level was lowered a maximum height of 9-ft. The erosion which occurred at groynes Nos. 6 and 7 was much less pronounced, the beach level being lowered a maximum height of only 2-ft.

Observations which were taken throughout a period of ten months have indicated that while the groynes very greatly accelerated the rate of accretion during South-Westerly seas they do not seriously interfere with the erosive action of Northerly seas. There does not, therefore, appear to be any danger of the level of the beach being permanently raised and the groynes rendered ineffective by the accumulation of material. It has also been demonstrated that groynes Nos. 8 and 9 which are constructed at an angle of 50° to high water mark are more effective than groynes Nos. 6 and 7 which are built at right angles to the beach.

It has been established that it is possible to exercise some control over the littoral drift by means of a system of groynes. Although considerable quantities of material have been arrested by the four structures already built the proportion of the littoral drift trapped by the groynes constitutes only a small proportion of the total amount of sand and shingle travelling Northwards along the beach. Sufficient data is available, however, to indicate what might be accomplished by an extension of the scheme. It would appear reasonable to anticipate that this would be accompanied by a correspondingly greater volume of accretion which must inevitably exercise a profound influence on the stabilization of the bar depth.

On the author's recommendation, therefore, the Board proceeded with the construction of eight additional groynes, on the lines indicated on the plan. Observations made under various conditions of the behaviour of the four groynes already built indicated that modifications in the design were necessary in the erection of more permanent structures. The new type (B) which was adopted consisted of three sections each of 50-ft. in length and supported laterally by stay piles and bracing. The effect of the rapid erosion caused by Northerly seas on the beach was to undermine the piles at the seaward end of the groynes. Waves breaking on the beach were deflected upwards striking the exposed end of the structure which acted as a powerful lever lifting the adjacent piles out of the sand. The action was progressive and extensive damage resulted during severe Northerly gales. The new type of groyne is not only very strongly constructed at the seaward end and could only be undermined by abnormally severe erosion but if such erosion did occur the damage would be localised to the seaward section and would be prevented by the gap between the sections from affecting the portions of the groyne farther up the beach.



Type B Groyne

The question of whether timber would prove a satisfactory material for the construction of permanent groynes on the foreshore received careful consideration in view of the presence of *Teredo* in the sea water at Greymouth. All timber structures which are exposed to the action of sea water at the port provide evidence of *Teredo* attack. The piles of the South Breakwater staging are particularly susceptible to the destructive activities of this borer and ironbark piles have been completely destroyed after only eight months immersion in the sea. Rimu and other native softwoods would have a very limited life at the South Breakwater or at the wharves, but the conditions which obtain on the foreshore are in no way similar to those which prevail elsewhere so far as *Teredo* attack is concerned.

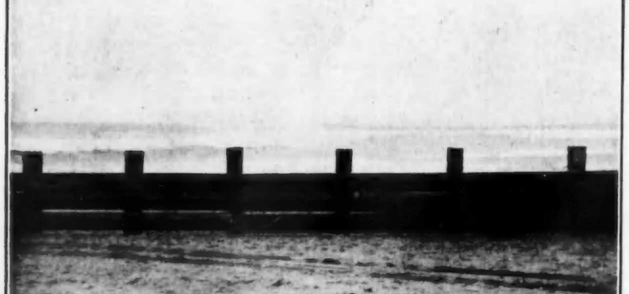
Teredo in its embryo stage is a very minute and delicate organism which floats in the sea water until it finds a timber pile or other member of a timber structure to which it adheres and then commences to burrow into the wood. Its means of subsistence is provided chiefly by the microscopic vegetable organisms which are always present in sea water and which are drawn by the *Teredo* through the small hole by which it entered the timber. A plentiful supply of sea water is essential for its continued existence and if it is denied this it quickly dies.

The groynes at Greymouth are subjected not only to violent wave action but also to the abrasive action of sand and shingle swept along the structures by the sea breaking on the beach. This abrasion by the material on the foreshore will prove an effective agency in combating *Teredo* attack and it is unlikely that

Port of Greymouth, New Zealand—continued

any *Teredo* would survive such conditions. Those which did escape destruction would be located at the joints between the planking and piles and would inevitably perish as the beach level rose and the groynes became covered with sand. It was expected therefore that New Zealand timber would prove a satisfactory material for the construction of the new groynes which were being built in three sections each 50-ft. in length with a gap of 5-ft. between each section. The cost of the new type of groyne was £207 or 27/7 per lin. ft.

The alternation of accretion during South-Westerly seas and erosion during Northerly seas continued to be unaffected by the construction of the groynes except that the rate of accretion was greatly accelerated and the volume of material arrested was considerably increased. The twelve months ending March, 1939 were remarkable for the prolonged and continuous South-Westerly seas which prevailed without interruption for several weeks at a time. Very convincing evidence was provided that the groynes were performing the function for which they were designed and that they were a potent factor in governing the depth at the bar. It was observed that when the groynes were in a condition to arrest the travel of the littoral drift the bar maintained a satisfactory depth but when they were buried in shingle and therefore inoperative the bar gradually shoaled. The month of February, 1939 was particularly interesting in this connection. Exceptionally heavy seas prevailed throughout this month and observations taken on the foreshore revealed that vast quantities of material were moving Northwards along the beach. Rapid accretion occurred in the vicinity of the groynes where the beach level rose to the top of the planking. About the middle of the month the piles in all the groynes were completely covered and at the seaward end of the structure the level of the beach was between 2 and 3-ft. above the tops of the piles. The bank of sand and shingle had extended Southwards while the foreshore to the North of the groynes remained normal. A few days later a bank was observed in the process of formation between the seaward end of the groynes and low water mark. This bank increased rapidly in extent and extended not only to the South of the groynes but also to the North along a part of the foreshore which had been previously unaffected by the travel of the littoral drift. It was apparent that the groynes had temporarily reached the limit of their capacity to arrest the Northward movement of material and that sand and shingle were passing the seaward end of the structures. The effect on the bar depth was immediately evident. A survey made on the 23rd February disclosed that the depth had decreased from 27-ft. 6-in. to 22-ft. 6-in. at H.W.O.S.T. The river velocities during the month had been abnormally low and a study of the records revealed that the conditions of both sea and river were analogous to those which obtained in February, 1936. The appearance of the foreshore in the latter period, however, was entirely different. In February, 1936 although considerable accretion occurred, it was on a much smaller scale and consisted of a series of low banks with deep depressions between each, the average beach level being 3-ft. lower than in February, 1939. It is clear, therefore, that the accretion which took place during the latter month was on a vastly greater scale than in the corresponding period in 1936. In the two periods under discussion the other two factors—sea conditions and river velocity—were similar in both cases while the greater volume of accretion which occurred during the month of February 1939 is reflected in the bar depth of 23-ft. at H.W.O.S.T. compared with 16-ft. at H.W.O.S.T. in February, 1936.



Groyne No. 8. September 9th, 1937.

Effect on Bar Depth

The effect of the groynes on the bar depth has been considerable. The rapid variations in the navigable depth of the harbour entrance which have in the past restricted the movements of shipping have become less frequent and of smaller amplitude. The bar depth has become stabilized within limits which enable ships to enter and leave the port loaded down to their full load draft. In the past rapid changes in bar depth have frequently resulted in ships having to restrict their draft and sail from the port with only part of their cargo.

The combined effect of the breakwater extensions and the system of groynes has been to increase the navigable depth and stabilize the bar. The following table gives the bar depths at H.W.O.S.T. for the past ten years. The average bar depth for the period 1938—1939 during which the groynes were operative shows an increase of 2-ft. 3-in. over the average bar depth for the previous eight years, while the difference between the maximum and minimum depths on the bar has been reduced from 11-ft. 4-in., the average for the period 1930—37, to 5-ft. the average for 1938—1939.

Groyne No. 8. September 16th, 1937.

Bar depth at H.W.O.S.T. for the past 10 years

Year		Av. Depth	Max. Depth	Min. Depth	Variation in Depth
1930	...	21-ft. 0-in.	26-ft. 2-in.	14-ft. 6-in.	11-ft. 8-in.
1931	...	24-ft. 6-in.	28-ft. 6-in.	17-ft. 0-in.	11-ft. 6-in.
1932	...	24-ft. 0-in.	27-ft. 9-in.	17-ft. 6-in.	10-ft. 3-in.
1933	...	23-ft. 5-in.	28-ft. 0-in.	16-ft. 6-in.	11-ft. 6-in.
1934	...	25-ft. 10-in.	26-ft. 6-in.	17-ft. 9-in.	8-ft. 9-in.
1935	...	24-ft. 0-in.	28-ft. 0-in.	16-ft. 6-in.	12-ft. 6-in.
1936	...	24-ft. 1-in.	29-ft. 6-in.	14-ft. 0-in.	15-ft. 6-in.
1937	...	24-ft. 7-in.	29-ft. 3-in.	19-ft. 9-in.	9-ft. 6-in.
1938	...	26-ft. 4-in.	28-ft. 6-in.	23-ft. 9-in.	4-ft. 9-in.
1939	...	26-ft. 0-in.	28-ft. 3-in.	23-ft. 0-in.	5-ft. 3-in.

Harbour Officials' Conference at Pretoria, Transvaal

Reports which have recently come to hand from South Africa show that a one-day conference was held at Pretoria in November to devise means to speed up the clearance of cargo and ships in the harbours of the Union and to increase their working capacity, as well to provide for their safety and defence. There was a large attendance of important personages and officials, including the Minister of Railways and Harbours (Mr F. C. Sturrock), the Directors of the ports of Capetown and Durban, the General Manager of the South African Railways and Harbours, together with representatives of the British Ministry of War Transport, the Association of Chambers of Commerce, the Royal Navy and local shipping interests.

The Conference was opened by the Prime Minister, **General Smuts.** In his address he said that the efficient working of the South African harbours was one of the best contributions that could be made to the war effort.

To-day only a few routes remained open to civil traffic, and among these the Cape route was second only to that of the North Atlantic. History and geography had called South Africa to play an important part, but this had been increased beyond all conception by the war.

The danger lay in overlapping and consequent inefficiency. Various steps had been taken; in particular the appointment of Port Directors at Durban and Capetown, and he appealed to the conference to give this experiment the fullest support. He himself had complete confidence in the two men appointed.

The alteration to the United States Neutrality Act would mean a great increase in traffic around the Cape. Even this would not be the end, for the war situation might transform the position in the Indian Ocean. So far the war had been kept from the Union by land, but it might come by sea.

"Do produce results," said the Prime Minister. "You are all business men, not parliamentarians, not debaters—at least not all of you. You are the men on the job; let us have the work done here."

The Discussion: Complaints and Suggestions

Mr. C. M. Hoffe held that the clearance of cargo was the crux of the problem.

Mr. E. X. Brain, System Manager, Durban, described the position at Durban as improving, but the absence of documents remained the chief difficulty; the Customs Department had to be satisfied about import permits.

Mr. J. Heddon, a member of the Merchant Shipping Control Committee, said that no permits were required from the British Commonwealth, but for a few unimportant exceptions. His opinion was that permits did not hold up cargo at the ports.

Harbour Officials' Conference at Pretoria—continued

Mr. P. T. Steyn, System Manager, Cape Town, thought it was the fault of merchants that the sheds were not cleared.

Mr. J. R. Whitehead, Durban, suggested that representatives of the Railways and Customs might, with advantage, go round the sheds daily.

Mr. T. Wilson, Durban, would like to see full authority given to one man on the spot, thus avoiding continual reference to Pretoria.

Mr. H. W. Frudd, representing the Durban stevedoring companies, said that stevedores at Durban could handle more work than at present. The port staff were working wonders, but crane-drivers and supervisors were not doing their bit. A crane obviously slowed up loading if it did not work to full capacity. He had seen on many occasions labourers loafing around when there was work to be done. Better supervision of labour was required at Durban. There was some underlying disturbance among native labourers, which resulted recently in a strike, but he was not prepared at the moment to state his suspicions about the cause.

Replying to Mr. Frudd, **Mr. Brain** said that the stevedores were supplied with many cranes which could actually deliver much faster than the stevedores could load. He had delegated a man to report on labour disturbances. There was definitely a shortage of labour. Far from the men not doing their bit, credit was due to them for handling a much increased tonnage without extra help. He agreed that labour supervision could be improved.

Mr. Hoffe pointed out that the Durban staff was increasing by 400 a month. Fifteen hundred girls had been taken on. No men were now being released for active service.

Mr. S. Watson, System Manager, Port Elizabeth, said there was a grave disparity of pay at Port Elizabeth. This disparity caused a labour shortage and they could only obtain the dregs of coloured labour. As in Durban's case, there was lack of supervision and work was being held up. Supervision was required by men chosen from the coloured people themselves.

Mr. Sturrock admitted it was a justifiable charge that natives were not paid enough, but obviously globular wage increases could not be made at once. Anything short of this would be undertaken. In cash benefits and improved rations considerable improvements had been made this year. He suggested that a "gang bonus" system, which was a modified form of piece-work, might be introduced.

Mr. Brain said that such a system would increase breakages and would "come back" on the railways in the form of claims.

Replying to **Mr. Mushet,** who urged a tightening up of the permit system, **Mr. Sturrock** agreed that the present system was unsatisfactory but steps were being taken to tighten up the restrictions. As up to 25,000 persons passed through a busy South African dock every day it would be understood how difficult it was to evolve an absolutely fool-proof system. The fact that real subversive elements had not been able to gain access into dock areas was clearly shown by the complete absence of sabotage or of any acts detrimental to the war effort.

Conclusions

When the conference ended **Mr. Sturrock** in a statement to the Press, expressed himself as well satisfied with the results achieved. Certain weaknesses had been revealed and appropriate steps would now be taken.

Greater possibilities of co-operation had been opened up between the Government departments and the Royal Navy and the British Ministry of War Transport. More labour would be made available for harbour work. A real difficulty was the congestion caused by Vichy ships and their cargo. Steps would be taken for the disposal of such cargos.

Harbour Protection

Further protection for the harbours was discussed at length and suggestions were put forward for tightening up control. There had, however, been no indication of subversive activities in dock areas.

The co-operation of the commercial community had been willingly promised in the general effort to bring about improvements. Rival claims from Durban, Cape Town and Port Elizabeth had not once been brought forward.

Notable Port Personalities

XX.—Sir Arthur Munro Sutherland, Bt., K.B.E., D.C.L., D.L., J.P.

Sir Arthur Munro Sutherland, Bt., K.B.E., Chairman of the Tyne Improvement Commission, has been a member since December 1911, when he gained, in a contested by-election a seat on the Board as one of the Representatives of the Traders' Class of Dues Payers. In 1930 he was elected Deputy Chairman and 5 years later, to the Chairmanship of the Board, which office he still occupies having been prevailed upon by the unanimous wish of the members to continue as Chairman during this difficult war period. His wide grasp of the work of the Commission and his unrivalled knowledge of the industrial resources, potentialities and requirements of the River Tyne and surrounding district expressly fit him for the position. In the present state of emergency he also holds the position of Chairman of the Port Emergency Committee and is a member of the Ministry of War Transport Shipping Advisory Council. Numerous improvements have been carried out at the port during his term of Office as Deputy Chairman and Chairman.

Sir Arthur also occupies Chairs in various business concerns. He is Chairman of B. J. Sutherland & Co., Ltd., (Shipowners, Shipbrokers and Coal Exporters); Sutherland Brothers Ltd., (Flour and Grain); Donkin & Co., Ltd., (Ships' Steering Gear); Tyne Tees Steam Shipping Co., Ltd., (London and Continental Lines of Passenger and Cargo Steamers); Free Trade Wharf Co., Ltd., London; Barnett Brothers Ltd., (Shipbrokers) London; Aston Martin Ltd., Motor Works, Feltham; Blyth Dry Docks & Shipbuilding Co., Ltd.; White Brothers (Southampton) Ltd., (Yacht Builders) and John Bowes & Partners, Ltd. (owners of large collieries). For a number of years Sir Arthur owned the Newcastle Chronicle and its associated papers having the largest circulation in the North of England.

Sir ARTHUR MUNRO SUTHERLAND, Bt., K.B.E., D.C.L., D.L., J.P.

His public appointments have been equally varied. He was elected Chairman of the North of England Steamship Owners' Association (1913), President of the Chamber of Shipping of the United Kingdom (1930) and President of the Institute of Chartered Shipbrokers (1936-38). He is and has been for a number of years, President of Newcastle and Gateshead Chamber of Commerce, Chairman of Newcastle Commercial Exchange Co., Ltd., and President of the Shipping Federation, London.

He has served on, and is a member of a number of Government and other Committees connected with shipping, is a Citizen and Feltmaker and Shipwright of London, a D. L. for Northumberland, a D.C.L. of Durham University, a Knight of Grace of the Order of St. John of Jerusalem, and in 1939 was decorated, by the King of Norway, Commander with Star of the Royal Norwegian Order of St. Olav to mark the esteem of the Norwegian Government for his enterprise and courage in helping in the development of the Anglo-Norwegian Trade. He is also on the Board of many Associations for Mutual Insurance of Steamers and Freights, is a Governor of the University of Durham College of Medicine and a Governor of King's College and Chairman of Governors of the Royal Grammar School at Newcastle upon Tyne.

During the war of 1914-18 and in a period of great shortage of tonnage Sir Arthur was instrumental in liberating from the Baltic 83 British ships representing about 380,000 tons and in an effort to tide over the depression which took place in shipbuilding in 1934 he placed many orders for ships which was highly appreciated by both shipbuilders and workmen.

His work in the public interest has been prominent. Entering Newcastle Council in 1910, he was appointed Sheriff in 1916, and in 1918 Lord Mayor of the City. In 1936, he was presented with the Honorary Freedom of the City in recognition of the exceptional and outstanding public services which he had rendered.

His benefactions to his native City have been substantial including gifts to and efforts on behalf of the Aged Merchant Seamen, the Blind and other humanitarian causes. His old school, Newcastle Royal Grammar School, has received his special attention and assistance. In 1936, Sir Arthur contributed £100,000 for the building of a new Medical College in this City and a few years before he erected an up-to-date Dental Hospital at a cost of £12,500. Tyneside community, as a whole, is much richer by his presence and posterity will benefit handsomely by his munificence.

Correspondence

To the Editor of "The Dock and Harbour Authority"

The Port of Hong Kong: Physical Development

Dear Sir,—

In continuation of my letter to you dated 12th January:

Whereas the *first need* is an impartial Trust; so the *second need* is the early adoption by the Government of a comprehensive scheme for the development of the harbour, embracing every section of its frontages and foreshores; not only that facilities more suitable than those already existing may be provided for the more economical handling of the present trade, and, as far as can be foreseen, the near future trade, but, in order also that areas which may be required for more distant future development may not be alienated.

Whilst Sir David Owen has given much thought to the "first need," in my opinion he has failed to give sufficient consideration to this "second need," which, in the end, is perhaps the more important of the two. His recommendations, as I interpret them, are really, in effect, expressions of opinion on proposals presented to him by various people in the course of his enquiry in Hong Kong.

But, before proceeding to comment on these, may I enumerate some of the many considerations which affect the problem, and which, when the time comes, will have to be carefully weighed by the Board of Trustees to reach final conclusions based upon the broad claims of the Colony's general welfare?

Apart from issues such as the following, which will determine the locations where developements should take place and the form of design of any works:—

1 Most convenient positions for the various trades having due regard to the locations where the present trades are carried on;

2 Suitable depth of water existing or susceptible of improvement at reasonable cost;

3 Practicability of economic construction;

4 Direction and intensity of prevailing winds;

5 Direction and speed of tidal currents and their probable scouring or silting effect by the construction of new works;

6 Accessibility;

7 Practicability of providing junk basins contiguous with transit sheds and storage warehouses; and

8 Practicability of providing shelter whereby steamers and small craft need not leave wharves or basins during typhoon gales;

there are many other aspects to be considered such as:—

9 Railway communication and the economic division of South and Middle China's trade, in mineral and agricultural products not yet exploited and of industries not yet fully developed, between Hong Kong and Shanghai, by rail to the former versus by the Yangtze to the latter.

En passant: This "economic divide" I place on a line running East and West through Hengchow in the province of Hunan, some 375 miles north of Hong Kong and about 340 miles south from Hankow.

10 Analysis of the existing trade and the "flow" of imports and exports; their origin and destination and the numbers of vessels, ocean-going and coaster steamers, river steamers, junks and barges, engaged in the trade, and their draughts on entering and clearing the Port, the possible increase in the draught of ocean-going steamers due to improvement in the depths of both the Suez and Panama Canals; and shipping accommodation existing and projected at Shanghai, at ports in Japan, and on the Pacific Coast of Canada and America.

In this connection; Hong Kong is a terminal Port and so vessels do not generally enter or leave the harbour with full cargoes; and are, therefore, not loaded down to their maximum draught.

11 Free storage.

This is a very important factor; for does not the length of time which consignees are granted "free occupancy" of transit sheds or space for their goods, to a great extent, determine the extent of quay and shed accommodation which has to be provided, and thus the capital to be spent and the charges necessary to be levied on the trade? Hong Kong gives 7 days, Shanghai 10 days, Singapore 7 days and Kobe (Japan) 7 days. With ample supporting warehouse accommodation provided adjoining the transit or quay shed or storage space, I see no reason, other than delay caused by typhoon gales or the fear of them, why in Hong Kong, all goods should not be removed from transit space within a period of 72 hours. And this can be accomplished where the disposition of ship and junk basins can be so arranged to meet all conditions and yet provide shelter for steamers and small craft during the typhoon season (May to October); and

12 Probably the most important: The provision of wharfage and cost.

I gather from Sir David Owen's remarks that he was in agreement that the existing berthage in the harbour is unsuitable in design to allow of the most economical handling of cargo being obtained. Berthage provided with transit sheds at the back of the wharf road, although more expensive to construct than the types of narrow piers existing, is the more suitable design in that it secures:—

(a) Less damage to goods and less actual cost for the transport of goods between ship and shed;

and compared with loading or discharging a vessel anchored in the stream:—

(b) Reduction in handling costs.

(c) Quick turnabout of vessels in port, more particularly during the typhoon season.

(d) Less broaching of packages and less risk of pilferage.

(e) Less frequent handling; an important factor in the case of flour.

(f) Water and oil fuel can be obtained at less cost direct from pipes laid along the quays.

(g) Less road congestion.

(h) Less dependence on unskilled labour.

This is a most important factor when we bear in mind the effect of past labour strikes (notably that in 1922); the probability that Hong Kong will have to meet intense competition for trade in the future; and how rapidly science and machine power in the past few decades have so changed the old tempo of life and destroyed the old balance of human labour and production.

Mr. JOHN DUNCAN, M.Inst.C.E., formerly Port Engineer, Hong Kong.

As regards cost of providing wharfage versus loading and unloading in the stream: In 1924 I arrived at the conclusion that to yield 7% (covering maintenance charges, loan interest and capital redemption over a period of 36 years) on the capital expense of providing the necessary quay wall, having a depth of 34-ft. of water alongside at L.W.L.O.S.T., it would be necessary to make a charge, on the basis of a rate of working of 200 tons of cargo per annum per lineal foot of wharf, of only 55 cents. (in 1924 = about 1s. $4\frac{1}{2}$d.) per ton of general cargo discharged. This figure was so far below the charges levied in 1924 for the transport of goods between steamers anchored in the stream and the shore that the expense of providing wharfage was then justified. In 1941 the Hong Kong dollar was worth about 1s. 3d. around which figure it has been more or less "pegged" for a few years and no doubt the cost in dollars in 1941 would in consequence be higher. This is a question which will have to be reviewed again by the Trustees.

Then there are questions of secondary import to be considered: Services and other works, adjuncts to shipping and trade, such as: Ferry services (passenger and vehicular); typhoon shelter for small craft; facilities for bunkering coal and oil fuel; water and electricity supplies; facilities for ship repair; airport accommodation; and reclamation, etc.

I have endeavoured to outline the scope of the enquiry and investigation which will now devolve upon the Trustees as their primary duty. The task may appear to be a formidable one, but this is really not so; for much of the information likely to be required by them has already been recorded and subjected to critical examination.

It is to be regretted that the Government did not, during the past 17 years, follow the advice tendered to them; for a complete comprehensive scheme of development could well have been adopted, so that, at the close of hostilities, when the Colony is once again in British possession, its place as one of the major trading points of the world could be established unchallenged and unchallengeable.

Correspondence—continued

As Sir David Owen remarks there are many public-spirited (and I would add " far-seeing " and "shrewd " men in Hong Kong who will be willing, in the interest of the Colony, to give their services free in the capacity of Trustees of the Port. Those business men, by whose opinions the Government must be largely guided, together with thier official co-trustees and wisely guided by their chairman, will, I am sure, approach the subject with that same pleasing breadth of view, showing a ready apprehension of present and future requirements and full realisation of the difficulties; and with that same will to overcome them as was characteristic of their predecessors in Hong Kong: And, as a result of their study of the whole subject and their full consideration of the many proposals and schemes already put forward, some by private persons, some official, some modest projects and some involving millions of money, there will evolve a scheme of development acceptable to the Government and to most people concerned in the trade of the Port. Such a scheme may well be termed " The Eclectic Scheme of Port Development."

Whatever recommendations the Trustees may make regarding the order of precedence to be given to the various sections of their scheme of development, and the order of progression to be followed towards the completion of each section, the extent of works they may recommend for immediate construction must be based, primarily, on a consideration of what developments are necessary for the trade of the Port as at present carried on.

From all I have already written, it will be appreciated that, in the limited space available in your excellent periodical, it is impossible to deal adequately with any of the various proposals which have been put forward for the development of the Port. Indeed, even if that were possible, I doubt that readers' interest in the subject could be sustained.

Sir David Owen's Proposals

I will now proceed to make comment on a few of Sir David Owen's recommendations commencing with those which, in effect, are really adjuncts to shipping and trade. Your readers will find it advisable to refer to illustrated supplements which were published with issues of *The Dock and Harbour Authority* for May, 1926 and December, 1936.

Railway Station

Ever since the railway station was erected in 1910-1911 it has been " in the wrong place and ought to be removed." Having regard to railway communication with the Wharf and Godown Co.'s premises it could, with advantage, have been placed in a better position. But how many stations in this country are in the ideal position?—very few. Wisely, Sir David Owen says:—Let the question of its removal " be considered at some future time."

Star Ferry Pier, Kowloon

" The Star Ferry Pier at Kowloon point is in the wrong place and should be removed." Its position is not an ideal one, not only on account of congestion but also in regard to manœuverability, of craft at certain states of tide. The new position suggested has much to commend it, but again Sir David Owen wisely says, " leave it for consideration at some future time when congestion becomes greater."

Admiralty Depôt, Kowloon

" The admiralty camber, torpedo-boat basin, oil and coal fuel depôt on the west side of Kowloon Peninsula are in the wrong place and ought to be removed." There is some foundation for this assertion for it precludes development for commercial purposes in this vicinity; but, I imagine, the decision on this recommendation will be found when the Admiralty presents its *quid pro quo*.

Harbours of Refuge

Then there is the recommendation: As soon as practicable fill in the present typhoon refuge harbour, and, instead of completing the reclamation at Cheung Sha Wan to the lines (that of the proposed breakwater) laid down by the Town Planning Committee, construct another harbour of refuge. I agree with Sir David Owen's conclusion that the land so acquired would be a valuable acquisition and possibly the premium obtained by its sale, apart from the premium acquired by the disposal of the land to be reclaimed at Cheung Sha Wan, might defray the cost of constructing the new refuge. But, is the proposal a sound one?

The shelter as proposed and the disposition of the entrances will, I concur, afford slightly better protection for craft from typhoon gales than that given by the existing shelter, but the cost of protective works will be found to be high in relation to the area enclosed.

Sir David Owen says: " It is a little further away but the extra distance is so small as not to be any detriment." With this opinion I disagree entirely. As a matter of fact the extra distance is over one mile further away from the area of greatest activity which is centred between West Point and Hong Kong Central, and, unfortunately, having regard to the direction of typhoon winds of greatest frequency, in the wrong direction.

Typhoons are terrific storms having wind velocities at times, exceeding 100 m.p.h. In 1931 a wind velocity of 130 m.p.h. was recorded in Hong Kong. A large typhoon affects the weather over an area 300 miles from its centre and gale force is reached within an area of about 60 miles radius. There being on an average 16.5 per typhoon season (May to October) it will be appreciated that the financial loss to shipowners, junk and lighter people, caused year by year through delays consequent upon typhoon weather and more especially the fear of same, must be enormous.

Study of the records of the Royal Observatory, Hong Kong, for the years 1884 to 1923, shows that, in that period of 40 years, 60 typhoon gales were experienced in the Colony. The winds, it is recorded, came mostly from the East with some North, or less frequently with some Southerly wind influence. Of these 60 typhoons, 50 induced winds from directions varying from N.N.E. to S.S.E. and only 9 from a westerly direction. With the exception of the remaining one which occurred on the 18th of September, 1906, when the winds from the South attained a velocity of nearly 100 m.p.h., and was the cause of the worst tragedy on record (10,000 lives lost in the harbour alone, including the Bishop, the Harbourmaster and 13 other Europeans), there is no other record up to 1923 of a typhoon blowing from the South.

" John Chinaman " is a very industrious, frugal-living fellow, but there is so much competition that he has difficulty in obtaining a living from the trade: During 1935, 18,000 junks engaged in foreign trade, entered and cleared ports in the Colony, and the number engaged in local trade during the same year was 27,500. In consequence, instead of seeking shelter when the first typhoon warning signal is hoisted, the junk master usually elects to remain on his job as late as possible. Incidentally, if he is the last in the shelter he will be the first out. When he does decide to " cast off " he has, at least, 5 times out of 6, to beat up against strong north-easterly winds sometimes approaching gale force, which must be done to reach the existing or the proposed shelter. It is therefore not surprising that the junk people complain of the difficulties they at present experience. How much more so will their difficulties be; how much more valuable time will be lost to trade; and how much more will the lives of those poor people be endangered, if the recommendation put forward by Sir David Owen is put into effect? Surely, he did not consult the junk masters' guild; for, had he done so, I am sure he would not have fallen for this proposal!

In 1924 my recommendations in regard to typhoon shelters were—

> " . . . Without the addition of a spur from the existing " breakwater to protect the southern entrance to Mongkoktsui " Harbour of Refuge recommended by the Consulting En- " gineers (estimated *then* to cost $630,000 at 2/6=£78,750) " there will be sufficient area of the refuge closed to westerly " gales to accommodate all the small craft likely to make use " of this shelter, when the new accommodation in the schemes " of the Port Development recommended is available. To " give immediate relief, and thus avoid the necessity for craft " to use the portions of the refuge disturbed by gales blowing " from west to south-west, I recommend the provision of " alternative accommodation at Kwo Lo Wan pending the " provision of shelter by the construction of wharfage."

It was anticipated that eventually this shelter would no longer be required and valuable land would then be acquired, by reclamation of the area enclosed by the protective works.

I note Sir David Owen draws attention to a " probable site for a new Harbour of Refuge at Tai Wan " mainly for craft used in connection with the " Air Port Services " and on the plan which accompanied his report the lines on which protective works should be constructed are shown. This shelter is in the very same position and similar in many respects to the shelter, above referred to, which, in 1924, I recommended as a temporary measure. With the disposition of the northern entrance I am in agreement, but, in my opinion, the provision of a southern entrance may well turn the shelter into a veritable death trap. In 1924 I stated: " It would appear therefore, that, in any system of docks to be provided, a southerly entrance requires least protection from typhoon gales." This must not be interpreted to mean that wherever practicable protection from all directions need not be provided. Indeed, it must. Just think of what happened in September, 1906. If this shelter is ever constructed I strongly advise that only one entrance be provided and that on the north side.

In regard to Causeway Bay shelter, Sir David Owen remarks: " the proposed ferry pier opposite Marsh Road would incidentally have the effect of affording some protection to the western entrance to Causeway Bay from heavy seas caused by westerly gales."

I think it will be found that this small projection (of, shall we say, 100 yards at a distance of half-a-mile from the shelter entrance?) will have little or no effect.

When Sir Maurice Fitzmaurice visited the Colony in 1920 the reclamation of Wauchai Bay, known as " The Praya East Reclamation Scheme" was about to be commenced and I discussed with him the possible detrimental effect the alignment of the protecting sea wall might have on the western entrance to the shelter.

Correspondence—continued

This question is fully dealt with in my report, the recommendation being the reclamation of an area of over 240,000 square feet opposite Kellett Island, for the purpose of deflecting from the refuge entrance heavy seas caused by a typhoon which may pass near and to the north of the Colony; typhoons in this position induce gales from a westerly direction, one of the worst experienced being that in 1908.

Ferries

Ferries across the harbour and the transport of passengers to and from Hong Kong by river steamboats is an important consideration which has to be taken into account in any scheme of development.

Later on, I shall refer to one important reason for the great movement which goes on in Hong Kong. For the moment, suffice it to say that, apart from the considerable amount of passenger transport done by sampans, the number of passengers moving to and from Hong Kong Island and the Mainland, Canton, Macao, etc., is estimated to be about 175,000 per day. The Yaumati Ferry Co., organised and managed entirely by local Chinese, runs the vehicular ferries across the harbour and two other services to points on the mainland in British territory. In addition to the large number of vehicles ferried the company carries about 40 million passengers a year; i.e., about 100,000 per day. The Star Ferry Co., the oldest ferry service, crossing direct over the shortest width of the harbour to Kowloon Point, carries approximately 28,000 per day.

For the better regulation of this traffic and to relieve as far as possible congestion on Connaught Road, I recommend in the Scheme of Development which I advised should be put into immediate effect at Hong Kong Central, and to which I shall refer later on, that the ferry piers be located at each end of the scheme from which Eastern and Western services respectively would operate. By this arrangement the routes of ferry services would not pass through an area likely to be used extensively by other craft. The vehicular ferry service recommended was put into effect and, from what Sir David Owen says, the traffic has apparently already reached capacity. To provide for future increase in this traffic he suggests another service to operate between Marsh Road, Wanchai and Gillies Avenue, N.E. corner of Hung Hom Bay. This proposal was first mooted by the Director of Public Works in 1922 (the late Mr. T. L. Perkins, C.M.G.), and it was fully discussed in connection with Town Planning. Whilst I considered the proposal, so far as the Hong Kong side was concerned, had much to commend it, by dissipating the traffic, and, if not relieving, at any rate not adding to the great congestion already existing at Hong Kong Central, I raised objection to the site proposed for the pier on the Kowloon side, that location, in my opinion, being eminently suited to the purpose of providing for the discharge, storage and bunkering of coal and oil fuel. For that reason the Town Planning Committee advised the Government not to alienate the area referred to or in fact any area of Hung Hom Bay pending the adoption of a complete scheme of Port Development.

Coal and Oil Fuel Bunkering

In 1923 import of coal amounted to 1,037,530 tons and the amount exported was only 205,140 tons. But the amount bunkered was 606,060 tons.

With the exception of that imported by the Admiralty, and by local industrial and shipping companies coal is handled by lighters and storage is located principally at Yaumati and Lai Chi Kok. Excepting Admiralty storage; oil installations are at Taikoktsui, Lai Chi Kok and North Point. As bunkering of coal and oil by lighters is so dependent on labour and costly (made more so by the fact that storage is located some distance from the shipping centre) I considered that, in any scheme of development, provision should be made in a convenient locality whereby more economic bunkering of vessels could be accomplished.

The locality I considered best suited is that referred to above, viz.:—the N.E. corner of Hung Hom Bay. The design of the coal depôt and oil fuel installations recommended was suitable for the erection of mechanical conveyors and pipe lines whereby coal and oil fuel may be delivered direct from colliers and tankers to storage and loaded to ships at piers or to barges in a basin thus providing for the more economical handling of this trade. The scheme, which could be put into effect independent of the development of Hung Hom Bay, was estimated to cost $2,290,000 (in 1924, roughly £285,000).

Reclamation

This work is largely a matter of supply and demand; and the practicability of economic construction not only in regard to protective works, but also to the cost of reconstructing drainage works in back areas such as over the thickly-populated area abutting on the Harbour of Refuge on the west side of Kowloon Peninsula. But there is, however, another consideration, viz.: the effect that reclamation may possibly have on other sections of the harbour.

The bold scheme of reclamation, *immediately to the West of the R.N. Dock Yard* suggested by one of my former assistants, Mr. Andrew Nicol, is an excellent one. If/when its construction is contemplated the question of its effect on the R.N. Dock entrance will no doubt be raised. In my opinion the effect will be beneficial, in that it will at least help to maintain, if it does not slightly increase, the depth of water outside the entrance.

Regarding the extensive areas of reclamation proposed in *Kowloon Bay:* I see no objection to their being carried out when required. With the exception of that on the Eastern side which is shown extended to embrace Kun Tong foreshore, the limits are approximately those laid down by the Town Planning Committee.

Foreshores inside Lye Mun: In my report I recommended that the foreshores immediately within Lye Mun ("Mun" in Chinese meaning an "entrance passage or doorway") viz.:—Chung Lui and Yau Tong Wan ("Wan" in Chinese meaning a "Bay") "should remain as far as possible in their natural state, so that seas entering the harbour through the Eastern entrance may disperse and expend their force rather than be propagated up the harbour." The proposal to construct boat-building yards in Yau Tong Wan is not an extensive reclamation, but this question will not arise unless the recommendation to construct the harbour of refuge at Cheung Sha Wan is adopted.

Limitation of space will, I am sure, preclude further comment on any more of the many adjuncts to shipping and trade: so I must now ask permission to proceed in my next and concluding letter to make some observations on what perhaps is the most important part of this subject, viz.:—*The Provision of Wharfage.*

Westbury-on-Trym,
Bristol.

Yours faithfully,
JOHN DUNCAN.

4th February, 1942.

Concrete in Sea Water

*Continuation of Discussion on Mr. Homer Hadley's Paper**

Mr. E. C. Jack, Senior Civil Engineer at Puget Sound Navy Yard: Any viewpoint of the subject of concrete in sea water should be somewhat philosophical, in that disintegration or deterioration may or may not be serious, depending upon the rate and keeping in mind the anticipated life of the structure. So many of the construction people with whom the writer does business consider 10 or 20 years a long time, and anything that might happen after that they believe is immaterial. However, one needs only to look back over the centuries to realise that this matter of ships is a long range, continuing one extending far into the future. The U.S. Navy is primarily interested in ships, and waterfront improvements to serve the ships should be provided with an eye to a life of at least 100 years. Thus, what to one person might negligible breaking up of the structure, to another would be a serious indication when a long life has been planned.

It has been noted that, in almost all cases where disintegration of one kind or another has taken place, there are contributing factors upon which the onus of the situation can be placed, thus clearing sulphate attack of the charge. Nevertheless, it is agreed with Mr. Hadley that the weakness of concrete toward sulphate attack has perhaps been over-stressed. Chemists have their catalytic agents and Metallurgists their eutectics; and, in a similar manner, is it not probable that the weakness of concrete toward sulphate and acid attacks makes possible the disintegration by other means, such as wave and frost action, abrasion, and chemical action? In several places in Alaska, notably at Kodiak and at Dutch Harbour, concrete has met with progressive disintegration between tide lines, whereas the remainder of the structure has withstood weathering very well for 25 years. Surely these cases must be a combination of sea-water attack plus frost and wave action.

Cement is a wonderful material that has been improved remarkably through the years, and its comparatively low cost, together with the rather universal distribution of the mills throughout the United States, makes possible the building of many structures that would have been impracticable years ago. It is far from perfect, however, and it may be well to review the most well-known weakness of cement and concrete.

Aggregate.—The quality and usefulness of concrete, with present-day cements, demand that aggregate be sound, chemically neutral or basic, and free of oil and other deteterious substances, in addition to being well graded. Thus, in some localities, concrete is very costly because of the distance from which aggregate must be brought. On St. Paul Island, in Bering Sea, it was necessary, one time, to carry gravel by ship from San Francisco, California. If cement acted slightly different chemically, then a wider range of aggregate might be used.

Proportioning.—The mixture must be a proper one with sufficient cement, and this item of cement, too, is relative: Witness the

*Published in the June, 1941, issue of "The Dock and Harbour Authority," reproduced from the Proceedings of the American Society of Civil Engineers.

Concrete in Sea Water—continued

amount of cement used per cubic yard to-day compared with the amount used 50 years ago.

Compounding.—The mixture must be put together in the right order, well worked, with one's weather eye open for numerous technical pitfalls.

Chemically Basic.—Cement and concrete in the green stage are strongly basic, and even when well hardened they are slightly basic. They are thus particularly vulnerable to all substances of an acid nature, such as humous, coffee, industrial wastes, sea water, etc. Just what goes on within the mass during hardening is still very much a mystery. A more thorough and complete chemical combination very probably would improve not only the chemical weakness but also reduce the troubles from erratic hardening and actually reduce the shrinkage.

Porosity.—Concrete made in the best manner known is quite porous under some conditions, and is thus vulnerable to wave and frost action and penetration of salt water to embedded steel, causing spalling and other such deterioration.

Time of Set.—The time of set is not subject to very good control, which very much limits the use of concrete under some circumstances. In fact, this lack of control can be very embarrassing at times, being either too slow or too fast, and this also nearly prohibits its use for repair work between tides.

Rate of Hardening.—This property naturally varies greatly with different kinds of cement, but in all cases it is absolutely dependent upon the temperature—too much so for comfort in cold climates.

Heat of Crystallisation.—This factor has been partly taken care of with the modified cements, but it is still difficult to disperse in spite of concrete being a relatively good conductor.

Workability.—In spite of great care taken to proportion cement and aggregate, the resulting mixtures are almost universally harsh; that is, the cement paste is not as smooth as one would like to have it.

Shrinkage with Hardening.—In practically all cases, concrete shrinks with hardening, thus causing troublesome construction joints.

Volume Change.—This phenomenon occurs, with addition or removal of moisture.

The foregoing résumé includes only the more obvious weaknesses. The items are inter-related in many cases. The first three will probably be present always as they are inherent in the universal use of any material of so cosmopolitan a character as cement. Modified cements and the use of admixtures are the result of trying to obviate some of these deficiencies. If a cement could be manufactured that would combine with all of the water ingredient, it would solve many of these problems.

In conclusion, the analysis of the many combinations of circumstances surrounding any one incident of deterioration is a complicated problem, and it has not been found possible in many cases to put one's finger definitely on any single underlying cause. Generally, it is a combination of poor circumstances, or a poor combination of circumstances, which made the deterioration possible. Therefore, sea-water attack by itself, it is believed, is seldom the cause of progressive disintegration, but in combination with other weaknesses it probably is a contributing factor.

Mr. Alfred H. Freudenthal, Assoc.M.Am.Soc.C.E., Resident Engineer, Marine Trust, Tel Aviv Port, Tel Aviv, Palestine:—In attempting to present the problem of resistance of concrete in marine work " in a nutshell," and in stressing the overwhelming importance of resistance against mechanical attack, Mr. Hadley is to be highly commended.

However, there are few engineering problems less suited to the dogmatic approach than that dealt with by the author, and if the question: " Does any form of deterioration occur in the concrete in sea water that would not develop if the exposure were changed to similarly agitated, similarly fluctuating, fresh water? " is answered definitely in the negative, this appears to be overstating the point.

The deteriorating action of the sea is of two kinds: Mechanical and chemical. The lack of distinct evidence of chemical corrosion in concrete of adequate design and composition (on which evidence the author rests his conclusions) indicates that two " lines of resistance " may be assumed to exist, the " advance line " of the two being the resistance of the structure to attack. However, there is definite evidence of chemical attack of sea water on the cement and the conclusion that " . . . . there appears to be no valid basis for believing that such attack occurs " (see heading " Conclusions ") is in contradiction to the results of very extensive and very careful research in America as well as in different countries of Europe. Resistance of Cements to Attack by Sea Water and by Alkali Soils," by Thomas E. Stanton and Lester C. Meder, " Journal " A.C. 1. vol. 9, 1938, pp. 433-464; Report of International Congress for Testing Materials," London, 1937 (see especially reports by H. Kuehl, F. Ferrai and A. Steopoe; and " Deterioration of Structures of Timber, Metal and Concrete Exposed to the Action of Sea Water," Dept. of Scientific and Industrial Research, H.M. Stationery Office, London, 1935 (report by R. E. Stradling).

It is not only the sulphate-of-lime attack that leads to disintegration of concrete; the tricalcium aluminate-hydrate is by far more injurious, although less frequent. Evidence of other corrosive effects of sea water, as well as of the inter-relation between the specific cement qualities and the intensity and speed of deterioration, has remained inconclusive, and additional research is needed urgently.

Questions of import are: " Is the effect of puzzolanic admixtures physical (that is, do they increase the density), or is it chemical?" The use of quick-setting cement in marine work creates an early mechanical resistance to external forces. " Do the mechanical advantages outweigh the chemical disadvantages?" The writer has observed conclusive evidence that aluminous cements are very resistant to the action of sulphur compounds in fresh ground water but has further observed that they are definitely weak in sea water. " Why then do they prove definitely weak in marine structure? " " Is this weakness due to physical or chemical action? " " Can pre-cast members be protected against corrosion by applying a bituminous coating to the surface?" Such investigations were begun at Tel-Aviv Port in 1939 in connection with the driving of concrete piles.

The foregoing questions are of considerable importance, and the opinion expressed by the author (see heading " Summary ")—that " There is no particular reason for research . . . . " is scarcely justified. If the metaphor used by Mr. Hadley were correct, the resistance against chemical corrosion might be considered a comparatively " strong link " in the " chain " of total resistance. This point is supported only by the author's testimony since the structures referred to do not demonstrate more than the fact that, in all cases where sufficient resistance of the concrete against mechanical attack has been insured, the amount of chemical corrosion has appeared insignificant. The metaphor of the " chain " and its " links " is not a happy one, since the wearing down of both kinds of resistance—the mechanical and the chemical—is not simultaneous but rather consecutive. Considerable deterioration is always preceded and initiated by deficiencies in the mechanical resistance, and there is nothing to support the opinion that after the breakdown of this " first line " of mechanical resistance the subsequent deterioration is not considerably intensified and accelerated by the chemical attack.

Observation of marine structures shows that the main damage to the concrete occurs within the tidal range as well as on horizontal surfaces above sea level (such as flat tops of breakwaters and sea walls) subject to constant spray. It is due to the evaporation and consequent concentration of the attacking saline solution. The fact that the strongest mechanical action of the waves usually occurs near the mean sea level, and thus within the tidal range (wearing down the resistance of the concrete against mechanical attack more rapidly than elsewhere), makes this range particularly susceptible to the concentrated chemical attack beginning in the eroded cavities and voids. Since the corrosion of the permanently submerged parts of marine structures is almost nil, due to the formation of a siliceous gel film that protects the surface, it is not the actual saline concentration of the sea water that is relevant, but the high concentration of the saline solution caused by evaporation. The circumstance that the eroding effect of the initial concentration of the sea water might be regarded theoretically as rather weak thus has no bearing upon the actual intensity of the attack upon concrete marine structures.

It is evident that the density and the impermeability of the concrete, particularly near the surface, are the principal qualities constituting the mechanical resistance of the concrete against attack by the sea. Theoretically, these qualities may be obtained by adequate grading of the aggregates, rich mixes, and (if this is not thought sufficient) puzzolanic admixtures or the admixture of other dispersing agents. Practically, however, the placing of concrete and its early resistance to mechanical attack is of overwhelming importance in attaining the required density and impermeability, and the best mix will be entirely deprived of its merits if there is even slight neglect in the procedure of placing. The considerable hazards encountered in the construction of marine works are sufficiently known and may not always be forestalled. In spite of all precautions it often may not be feasible to secure practically perfect conditions of placing and to prevent local damage of the concrete surface. Thus its capacity to resist mechanical attack is affected. If no resistance against chemical attack is provided for, relatively rapid deterioration of the structure will start locally, and it will extend gradually over parts initially unaffected. Adequate capacity to resist chemical attack, however, will counteract the injurious effects of local erosion to a considerable degree.

Although the author's statement that " the vitally important matter for concrete used in marine work is to have dense, impermeable concrete made of sound materials with adequate cover over reinforcement " may be fully endorsed, his opinion that " . . . . there appears to be no valid basis for believing that such attack occurs " is definitely contradicted by actual evidence (see heading " Conclusions "). The conclusion (see heading "Synopsis) " . . . . special precautions against sulphate attack are needless " is not justified, and its application in practice would deprive concrete marine structures of a highly valuable " second line of resistance."

Costing in Relation to Port Operation*

By GILBERT WILSON, A.M.Inst.T.†

Readers of this paper are asked to bear in mind that it refers wholly to peace-time conditions. War-time conditions tend to ignore costs and concentrate on output. Costing is a product of competition which is a feature of industry in times of peace and plenty.

Introductory

Of recent years costing in manufacturing industries has become more and more important. It is not too much to say that in the great mass-production manufacturing concerns the cost office is now the key department of the office organisation. Where the margin between a manufacturer's cost of producing an article and his selling price may be the fraction of a penny, prompt and accurate costing has rightly come to be regarded as of primary importance.

A voluminous literature has already grown up around the subject of this branch of accountancy. Out of this wealth of theory has been evolved a set of generally accepted principles, and "Cost Accounting," to give it its full-dress title, is now practised with increasing uniformity of method. While the authors of this literature have dealt at length with costing from the manufacturer's point of view, much less attention has been devoted to operating costing. It has not been entirely ignored, however, and costing methods in respect of transport by rail, road, water and air, have been dealt with in specialised treatises.

The neglect of costing in relation to port operation is therefore surprising. Ports may be regarded primarily as junctions between transport by sea and transport by land. The speed, efficiency, and economy with which they carry out their functions vitally affect the two forms of transport which they link. It has been estimated that only one-third of the shipowner's cost is attributable to the actual travelling time of his vessel, and that one-half or more is made up of the expenses incurred in port. In his paper on "The economics of port development" given before the Institute in July, 1930 (Institute Journal vol. xi, p. 442), Sir George Buchanan said "It has been found by experience that port terminal facilities and port charges are frequently a decisive factor in the economic situation, and that avoidable delays and unnecessarily high charges generally occur at the terminals."

The need for proper costing methods, if those delays are to be eliminated and those charges reduced, is manifest. The standard works on cargo handling and port operation give little more than a passing mention to costing, and there would appear to be room for an authoritative treatise on the subject. This study makes no claim to fill this requirement. In the space at his disposal the author has attempted only to show the value of a proper costing system to an undertaking performing cargo-handling operations at a port, and to give a brief outline of such a system.

It is realised that at most ports more than one body is concerned in performing cargo-handling operations and rendering charges therefor. This multiplicity of operators may or may not be desirable. Where there are many undertakings there is a corresponding number of separate establishment costs to be borne by each ton of goods; on the other hand, free competition for traffic, by the necessity for low charges and good service, stimulates economy and efficiency. For the purpose of this paper, however, it has been assumed that all discharging and loading of vessels, and landing, warehousing and delivery of goods is performed by the port authority; that is, the authority is entirely responsible for all movement of cargo from the removal of the hatches of the vessel to the time the goods leave the dock estate *en route* for their destination or, in the case of export cargo, for the reverse process.

Functions of the Cost Office.

The chief functions of the cost office may be broadly classified under four main heads:—

1. To discover the cost of performing any handling operation.
2. To prepare information from which the management may fix a satisfactory scale of charges.
3. To detect inefficiency and waste.
4. To supply detailed information to the financial accountant.

These functions may now be examined in more detail.

To Discover the Cost of Performing any Handling Operation

It will be obvious that the cost of performing any handling operation will vary with the type of commodity dealt with and the means used to deal with it. A man can move a sack of flour weighing 140 lbs. more easily than a bag of rice weighing 280 lbs., while he cannot move a tierce of tobacco weighing 10 cwt. at all. On the other hand, a crane can move eight sacks of flour or four bags of rice with the same ease and at the same cost as the tierce of tobacco. It will be apparent, therefore, that the cost office must ascertain the cost of every operation for each of the commodities dealt with and each of the possible methods of performing it.

In the undertaking with which the author is best acquainted, an extensive business is carried on in the discharging of cargoes of bulk grain. The equipment available to perform this discharge consists of a number of floating elevators of both the pneumatic and the bucket types, and several shore pneumatic elevators, besides a supply of casual grain workers, should it be decided to carry out the work by manual labour. A large proportion of the grain not warehoused is worked to railway trucks, the principal methods of handling being: (a) any one, or more than one, of the elevators can deliver the grain on to conveyor belts which carry it to silos, whence it is sacked off into receivers' sacks and loaded into railway trucks; (b) any of the floating elevators can deliver the grain outside into barges which are then towed to the shore elevators and discharged through the silos as above; (c) the grain can be sacked up in the hold of the vessel by bushellers, lifted by the ship's gear, weighed on the deck, and carried by hand gangs into railway trucks on the quay side. It will be obvious that each method of handling will produce a different cost, although the result achieved—the delivery of the grain to railway trucks—is the same. For delivery to craft or road vehicles or into warehouse there are at least as many alternatives.

The cost per ton of performing each operation should be extracted daily. Weekly and monthly summaries should also be compiled, giving a useful check on the tendency of costs to rise or fall. It must be remembered, however, that a monthly cost will absorb a short period of excessively high costs with a relatively small effect on the general average, and even if the overall cost is affected, it will generally be too late for remedial action to be taken. On the other hand, an upward leap in the daily cost will generally be observed within a very short time, and immediate steps may be taken to remove the cause of the increase.

The value of costs decreases with their age. "Costs should be news, not history" and, generally speaking, if costs are not compiled with the minimum of delay, the cost office degenerates into a statistical office and the value of its work is greatly diminished.

Direct Costs.—Handling costs may be divided into direct and indirect costs. Direct costs are those items which can be attributed wholly and directly to a particular job, for instance, the wages of men actually handling goods. These costs will be ascertained from an examination of the daily time sheets or time cards, on which the timekeepers record the wages of each employee and the number of hours he spends at each job.

Accurate booking of work performed by employees is a first essential of costing. Where employment is on a piecework basis, the labour cost per unit is constant* and the errors are unlikely to arise; but where labour is paid on a timework basis, any carelessness or inaccuracy in the recording of time will result in false and misleading costs which in certain circumstances may quite conceivably involve the management in financial loss.

The costing staff and the time-keeping staff must therefore maintain constant close contact in order that any inaccuracies, however minute, may be immediately rectified.

Indirect Costs.—Indirect costs are those which cannot be directly charged against any particular operation but which have to be allocated over a number of jobs according to some logical rule or system; for example the working costs of mechanical cargo-handling appliances.

The burden of indirect costs is largely, though not entirely, independent of output. A conveyor capable of carrying 150 tons per hour will consume little, if any, less power if its load is reduced, or even if it is running empty. It follows that an allocation of power costs on the basis of output is unsound. Moreover, the wages of any drivers and attendants will almost certainly be on a time-work basis, and the length of time the conveyor is in use will determine the number of repairs and overhauls which will become necessary. Generally speaking, therefore, "running hours" will prove the most equitable basis for allocating indirect costs.

The cost accountant must devote special attention to maintenance costs. It is seldom possible to be sure that an item of expense under this head really belongs to the period in which it is found. Repairs naturally always take place after the event, while overhauls are usually undertaken at fixed intervals or as trade permits. A wise manager will take advantage of a period of "off-peak" trade to withdraw a machine from commission for overhaul or repairs without reducing equipment below the level necessary to deal with current traffic.

These facts lend weight to the arguments in favour of allocating a periodical fixed sum, based on a predetermined estimate, for maintenance and repairs to machinery. Any difference between this allocation and the actual expenditure can be adjusted in a suspense account, and amended if necessary when the revised or supplementary estimate is rendered later in the financial year.

By this means the repair bill is spread evenly over the financial year, and the costs for the particular period in which expensive repairs were performed are not weighted by the whole cost of those repairs.

*Reproduced by permission from the October, 1941, issue of the Journal of the Institute of Transport.

†Port of Bristol Authority.

Costing in Relation to Port Operation—continued

The goods handled by each machine must also bear a charge to cover its depreciation. Plant depreciates in two ways; by wear and tear, which varies directly with its use, and by the passage of time, which lowers the value of the plant whether it is used or not. Sudden depreciation of existing plant will also occur on the introduction of new and improved apparatus which renders it obsolete. Depreciation, therefore, bears little relation to the amount of profits earned and must be provided for out of revenue. The most commonly used methods of making this provision are (a) the fixed instalment method, under which a fixed percentage of the original value of the asset, based on the estimate of its working life, is set aside annually, and (b) the reducing instalment method, under which a fixed percentage of the diminisning annual value is set aside. There are various other ways of providing for depreciation: the appropriate method to be used will depend largely upon the character of the machine.

Establishment Charges.—A sum representing establishment costs must be added to the sum of the direct and indirect costs in order to arrive at the total costs. The major portion of establishment expenses will consist of the salaries of the managerial and clerical staff and general office expenses such as telephones, stationery, lighting and heating, plus the wages of certain supervisory and time-keeping staff whose time cannot be otherwise allocated.

The allocation of establishment charges is best accomplished in two stages; first by a division of the total into departmental sub-totals, and then by a further allocation of these sub-totals over individual jobs. Departments may be regarded either as classes of traffic, as timber, oil, coal, etc., or as well-defined branches of activity, such as loading, discharging, or warehousing. The former will probably be found easier to operate for costing purposes.

The basis of division into departments is best determined at the beginning of the financial year by examining separately and distributing over departments, every item of establishment expense for the preceding year. No two cost accountants will agree as to the correct method of performing this departmental distribution. The methods adopted probably vary from port to port according to the nature of the trade carried on, but in most cases the principal factors to be considered will be the tonnage, and the relative costliness of handling, of each class of traffic.

Where office staff is organised departmentally, it will be possible to charge the salaries of certain clerical staffs directly to their departments; the salaries of the timber staff will be debited directly to timber, and so on. The remainder of establishment expenditure will have to be apportioned over the departments in as logical and equitable a manner as possible.

When each item of establishment expense has been apportioned the sum total of the establishment charges allocated against each department can be ascertained and calculated as a percentage of the whole. This percentage will then be taken as the basis of allocation for the ensuing year, though regard should be paid to the possibility of changes in trade before finally fixing the figure.

The second stage, the allocation of the departmental totals over separate operations, may be achieved in several ways, the most widely used method being an allocation directly proportionate to the sum of the direct and indirect expenses incurred on each job.

The establishment percentage to be added to the costs of each job is arrived at by means of the following calculation:—

$$\frac{\textit{Establishment cost} \times 100}{\textit{Sum of direct and indirect costs}}$$

This establishment percentage will fluctuate from period to period, and it is the business of the cost accountant to watch its movements in relation to fluctuations in trade.

(To be continued)

Port of Rangoon

Excerpts from the Annual Report of the Commissioners for the Year 1940-41

Revenue Account.—The year's working resulted in an excess of income over expenditure of Rs. 3,93,025 as against an estimated excess of Rs. 1,67,153. Compared with the previous year income shows an increase of Rs. 1,31,200 and expenditure (omitting the contributions to Capital Account and the Burma War Donation) a decrease of Rs. 1,35,742.

Traffic—The total net tonnage of steamers entering the port was 3,527,991, a decrease of 737,570 tons compared with that of the previous year. Of the 1,487 sea-going vessels that entered, 836 came alongside the Commissioners' wharves and jetties for the purpose of disembarking passengers and discharging cargo as compared with 867 in 1939-40.

Sea-borne Trade.—The total sea-borne trade of Rangoon amounted to 4,973,855 tons, representing a decrease of 457,410 tons or approximately 8 per cent. over the previous year's figure; of this total, 1,628,275 tons were handled over the Commissioners' premises, 249,051 tons less than in 1939-40.

River-borne and rail-borne Traffic.—Compared with the previous year there was a small increase in the volume of river-borne traffic passing over the Commissioners' premises and a small decrease in the volume of rail-borne traffic.

During the year 170,614 passengers by sea landed at, and 176,291 embarked from the Commissioners' wharves and jetties, compared with 219,437 and 189,631 passengers, respectively, during the previous year.

New Works.—The following are particulars of the more important new works in progress or completed during the year:—

Sule Pagoda Wharf—Berths Nos. 1-3.—In July 1939 an estimate of Rs. 71,50,000 was sanctioned for the reconstruction of these berths, the design approved being generally similar to that of Brooking Street. A start was immediately made on the work and after some delays owing to the difficulty of obtaining prompt supplies of certain of the materials, berth No. 3, representing the first stage, was completed during the year and brought into traffic use. This berth however is still equipped with only two 3-ton cranes, two others which were shipped having been lost in transit. As part of this scheme, a new Traffic Office to serve the whole Sule Pagoda Wharf was constructed.

Brooking Street Wharf.—The congestion at the wharves due to late receipt of documents and other causes rendered further accommodation necessary and an additional temporary godown, 108-ft. by 50-ft., was constructed at this wharf.

Replacement of Sparks Street Rest House.—The new Rest House at 37th Street, which was commenced the previous year, was completed and officially handed over to the Trustees on 4th October, 1940. This building, now known as the "Hajee Mohamed Esoof Esmail Rest House," provides accommodation for 245 persons. The total cost of construction was Rs. 1.85 lacs. The demolition of the old Rest House was commenced soon after the new building was occupied and at the close of the year improvements to the old site and the approaches to Brooking Street Wharf were in hand.

Re-alignment and improvement of the Lanmadaw foreshore.—In February, 1941 the Commissioners approved a general scheme for the re-alignment and improvement of the Lanmadaw foreshore and for preliminary works in the investigation of the problems connected therewith. Borings were taken and preliminary plans prepared but it was found necessary to postpone further consideration owing to the difficulties of obtaining the necessary steel supplies under present conditions. Improvements carried out during the year in pursuance of the Commissioners' policy of increasing and modernizing godown accommodation at Lanmadaw include the construction of six new godowns, 50-ft. by 50-ft. each, two as an extension to the north end of Block 'C' and the remaining four at Keighley Street, and the modernization of five godowns involving the provision of new raised concrete floors and new doors.

Jetties and sampan-landings.—A new jetty was constructed at Hteedan and two new sampan-landings at Kamakasit and King's Bank. In addition the Godwin Road lower jetty, the Morton Street jetty and the centre and downstream coal jetties at Rowett Street were replaced by reinforced concrete or screw pile structures.

General.—Rangoon Port (Amendment) Bill, 1940—This Bill, on the terms of which the Commissioners' views were invited by Government the previous year, was passed by both Houses of the Legislature in the Budget Session of 1941 but had not become effective at the close of the period under review. In its final form the measure provides for an increase in the number of Commissioners from 17 to 21. Three seats are abolished, *viz.*, those of the Rangoon Development Trust, the Burma Railways and one of the Burma Chamber of Commerce. Seven seats are added, *viz.*, one for the House of Representatives, one the Senate, one Burmese labour, one Indian labour, two Burmese National Interests and one as an increase in the existing representation of the Burmese Chamber of Commerce.

The report is signed by Mr. A. N. Strong, Chairman.

Publications Received

The **Anuario dos Servicos Hidraulicos** for the year 1939, issued by the Ministry of Public Works and Communications, Lisbon, contains a report of operations carried out under the Director General of the Hydraulic and Electrical Services during the year in question. In particular there is an account of the construction of the extension of the North Mole at the Port of Leixoes (Oporto) which will be the subject of special notice in a subsequent issue of this Journal. A statement is included of the expenditure on works at all Portuguese ports, both in the home country and abroad and a section deals with the dredging operations in harbours and rivers. There are a number of diagrams and some interesting views.

The **Revista de Obras Publicas** for December, 1941 contains a number of articles of general engineering interest which do not fall specifically within the purview of this Journal. It is published by the Escuda de Caminos, Madrid.

Notes of the Month

Humber Pilotage Rates.

The rejection by the Pilotage Committee of an application by the pilot staff for an increase of 25 per cent. in pilotage rates has been confirmed by the Humber Conservancy Board.

Oil-bunkering Installation at Lourenço Marques.

A new oil-bunkering installation has been ceremoniously put into commission at the Port of Lourenço Marques, Portuguese East Africa by the Governor-General of the Colony. The new installation comprises storage tanks and a packing shed.

River Wear Commission.

Recent changes in the membership of the River Wear Commision include the election of Mr. Summers Hunter, Major F. D. Nicholson and Mr. J. E. Dawson. Sir Hedworth Williamson has been co-opted to fill the vacancy caused by the death of Sir John Priestman.

Condition of Dunbar Harbour.

The Parliamentary Secretary to the Ministry of War Transport was asked in the House of Commons by Captain McEwen whether his attention had been drawn to the condition of Dunbar Harbour and whether any Admiralty assistance will be forthcoming for its repair. Colonel Llewellin, replied in the negative to the first part of the question but said he would look into the matter.

Durban Port Improvements.

The second of the two new deep-water berths, at the Port of Durban, Natal, complete with cargo sheds, wharf cranes and road and rail facilities, has been placed in commission. This quay, known as Q berth, together with R berth which was completed at the end of 1939-40, provides a total additional quayage of 1,240 lin. ft. with two cargo sheds, eleven 4-ton and one 10-ton wharf cranes.

Port of London Canteens.

It is announced in the press that the Port of London Authority has placed at the disposal of the Women's Legion, a building from which, under Ministry of Food supervision, hot meals will be supplied to dock workers, repair gangs and stevedores in the dock areas. The Women's Legion will cook all the food needed for a fleet of mobile canteens which are to be driven to the respective docks.

Submerged Obstruction in Table Bay Harbour.

Contact by a merchant ship with an under-water obstacle while anchoring in Table Bay has led, after investigations by sounding, to the discovery of an uncharted ridge of rock about 50-ft. long, lying in 28-ft. of water at low tide. The presence of this obstruction was unsuspected not having been revealed by previous surveys. The site is now marked by a buoy.

Port of Dublin Affairs.

Although the financial returns of the Dublin Port and Docks Board are not yet available it has been stated that a preliminary examination indicates a deficit for the year just closed of about £31,000. The trade returns for the last half-year have shown an upward trend. As regards improvements in the accommodation at the port the reconstruction of the Custom House Quay which has been in hand since last May is making good progress and it is hoped to have the first 300-ft. of berthage ready for use by the end of the present year. The total length of quay to be reconstructed is 1,790-ft. At the Alexandra Quay the second section of wall has been completed making a total new frontage of 280 lin. ft.

Wallasey Embankment Commissioners.

At the Annual Meeting of the Wallasey Embankment Commissioners, reference was made by the chairman, Mr. Hugh L. Roxburgh to the retirement on February 2nd of their engineer, Mr. T. L. Norfolk and a resolution was passed ordering a record to be made of his valuable services in connection with the construction of the Leasowe Embankment. Mr. Leopold Leighton succeeds to the appointment.

Table Bay Harbour Advisory Board.

The new chairman of the Table Bay Advisory Board is Mr. J. W. Mushet, M.P. for Maitland, who has been unanimously elected in place of Mr. E. S. Steytler, who has retired. Mr. Mushet has served on the Board for 21 years—longer than any other member. He was a member for 10 years of the Shipping Board and is a former president of the Cape Town Chamber of Commerce and of the Associated Chambers of Commerce of South Africa.

New Trinidad Harbour Board.

It is announced that the committee appointed by the Government of Trinidad to devise a permanent form of control for the new deep water harbour at Port-of-Spain has recommended the formation of a combined Board to operate the port, rail and coastal services, and that shipping and commercial interests should be represented thereon. The local Chamber of Commerce has endorsed the proposal with the proviso that subsidiary boards be appointed for the three services, with the present heads of the services as chairmen.

French (Vichy) Harbour Grants.

Allocation of 200 million francs and 5 million francs have been made by the Vichy Government for the reconstruction of the ports of Dunkirk and Gravelines, respectively. It is not stated when the work is to be put in hand but the intention is to equip Gravelines for the development of its fishing industry; while, at Dunkirk, there is a ten-year programme in hand which provides for the joining up of the new lock with No. 5 Basin and the completion of the Turning Basin. In addition to these new works, the reconditioning of the port in general is to be undertaken. The reconstruction of the berthage and its cargo-handling equipment are the subjects of a preliminary estimate of 300 million francs.

Cork Harbour Finances.

The Cork Harbour Accounts for 1941, as submitted to the Cork Harbour Board, show that the year's revenue was £35,519, as compared with £63,588 in the previous year, while expenditure was £48,935 as against £70,053. The year's deficit of £13,416 increased the adverse balance on net revenue account of £35,727. The accounts were approved. The general manager (Mr. E. Gayer), asked for his views on the prospects for the current year, said that expenditure would be about the same, £49,000, and dues revenue, taking into account the recent 50 per cent. increase in rates, should be about £36,000, with other revenue £5,000, leaving a deficiency of £8,000. He added that improved cattle shipments and the re-opening of Rushbrooke Dockyard justified the hope that revenue would exceed this estimate.

Progress at Cape Town Harbour Works.

Reports just received from South Africa show that the work of providing 4,000 lin. ft. of quayage in Cape Town new basin to form berths E, F, G and H, continues to make steady progress. At the end of October, the foundations for the new quay wall had been completed over a distance of 4,130-ft.; blockwork had advanced to 3,900 lin. ft.; while the length of quay wall completed to quay level totalled 3,469-ft. Cargo Shed E was in use and work was proceeding satisfactorily on Shed F.

The Falsterbo Canal.

The official opening of the Falsterbo Canal through the isthmus of Scania, Sweden, took place in January after the actual use of the Canal by some 300 vessels of tonnages up to 10,000. At mean water level the depth of water is 6.7 metres, and to ensure the maintenance of this depth, two locks have been constructed. Vessels drawing up to 6.2 metres and up to 20 metres in breadth may use the canal, which is open free of dues, by night as well as by day. A railway bridge crosses the canal and railway traffic has preference. When the bridge is not raised to permit the passage of ships there is a clearance of 3.9 metres underneath. Vessels wishing to enter the canal must stop one nautical mile from the pier heads and signal. The locks and bridge may only be passed by one vessel at a time.

The fact that goods made of raw materials in short supply owing to war conditions are advertised in this Journal should not be taken as an indication that they are necessarily available for export.

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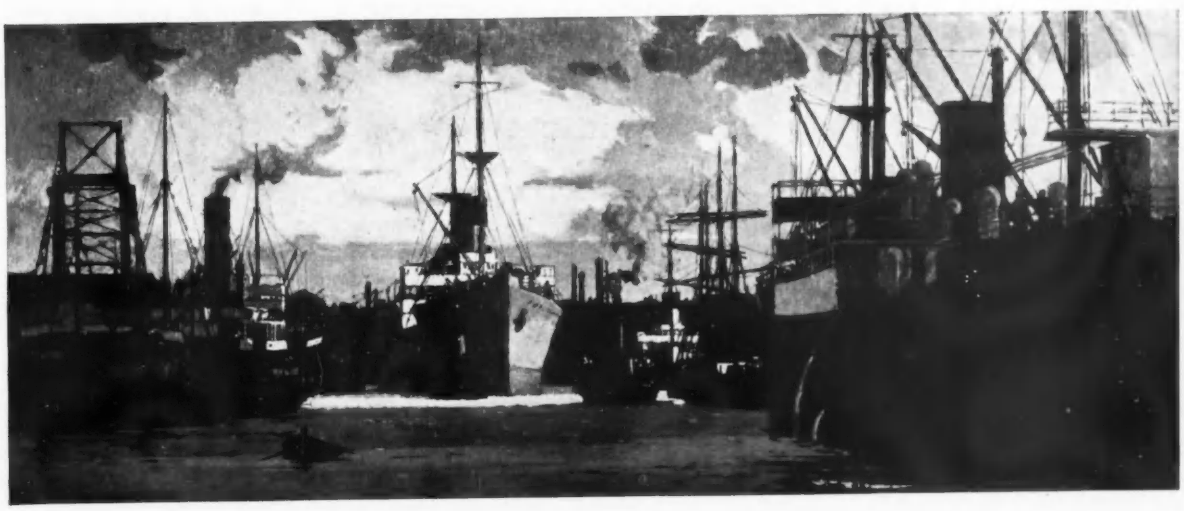

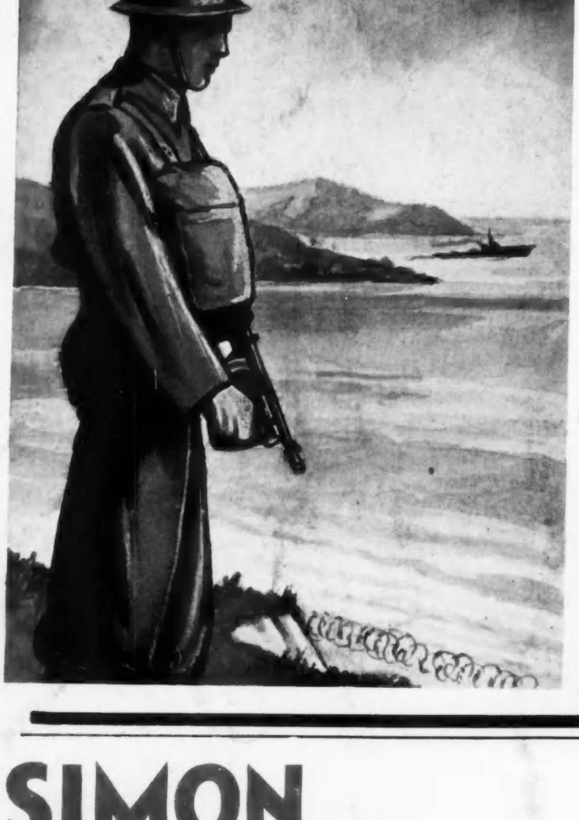

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